THE DOCTRINE OF THE SPHERE,

Grounded on the Motion of the

EARTH,

And the Antient

PYTHAGOREAN or *COPERNICAN*

SYSTEM OF THE

WORLD.

IN TWO PARTS.

By John Flamsteed

LONDON:

Printed by *A. Godbid* and *J. Playford*, in the Year 1680.

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And the Use of the

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THE PREFACE.

WHAT the Reader is like to meet with in the following Treatiſe, the Contents will inform him, what occaſioned the writing of it I have intimated in the firſt *Section*; I have farther to add, that I thought I could not perform any piece of Service, which might more juſtly deſerve acceptance, or be more uſefull to the Ingenious Student of *Aſtronomy* than this, wherein I have ſhewed him how all the Diurnal Appearances of the Sun and Stars are naturally made, and how laying aſide all *thoſe Old Projections* of the *Sphere*, which falſly ſuppoſe the Earths *Stability*, they may be repreſented, and the Problems concerning them anſwered by *New ones*, grounded on that true Syſtem of the World, which

ſuppoſes the Annual and Diurnal Motions of the Earth, propoſed firſt by *Pythagoras*, aſſerted by *Copernicus*, demonſtrated by *Kepler*, and as moſt agreeable to reaſon and experience approved and entertained by the ableſt *Aſtronomers* of our Times.

Hence I have given it the Name of *the Doctrine of the Sphere*, wherein if my Reader ſhall think I have anſwered but few of thoſe many Problems that may be propoſed, I muſt tell him, that though I have handled only the moſt ordinary and uſeful, yet if (as I ſuppoſe) he underſtands the Nature of Projections, and the Reſolution of *Spherical Triangles*; he will readily apprehend how other Circles may be drawn in that I have deſcribed, and more Triangles formed, whence anſwers may be given to any Problem concerning the *Phainomena* of the Sun or Stars, as eaſily as by any of the Ptolemaick Projections hitherto uſed and Taught.

And leaſt what I have writ ſhould prove uſeleſs to him for want of ſuch a perfect knowledge in *Trigonometry*, I have laid down the Analyſis or Canon, whereby every particular Problem is anſwered in words at length, for I know very well there are a ſort of diligent and curious Men in the World, who tho they may not at firſt apprehend the reaſon of a Rule, yet having frequent occaſion to employ it, may at length make themſelves Maſters of it, and to ſuch works of this Nature prove generally the moſt uſefull.

For whoſe ſake I have followed the ſame plain Method in the *Second Part*, where I have Taught how to find within what ſpace on the Earth the Solar Eclipſe is viſible, and where the principal *Phaſes* appear, by Calculation; as alſo how all the requiſites of the ſame

Eclipse may be found, for any given place, without the Calculation of *Parallaxes*; which useful Invention having never appeared in Publick before, I find my self obliged to give the following account of its Original, that I may not hereafter be accused of injustice to two of my singular kind Friends, the admirably Ingenious Sir *Christopher Wren*, (Master Surveyor of His MAJESTIES Buildings), and our Southern *Tycho*, Mr *Edmond Halley*.

It was in the *Winter* of the year 1676. that I light upon this Method; The Autumn before some spots had appeared in the Sun, and then I was observing a Compact one that made more than two entire Revolutions before it was wholly extinct; Examining my Observations to find the Reason of their different Appearances, I collected from them, that the spots adhered to his Superficies, and that they were carried round his Center once in 25 days and a quarter, the Northern half of that Axis on which this Revolution was performed, being inclined about 8 *Deg.* to the plane of the Ecliptick, betwixt the 12th and 18th Degrees of *Virgo*, which being concluded, I found that allowing what alterations must necessarily happen in their Appearances, by reason of the Earths Diurnal Progress in her Orbit, all my Observations would be represented as nearly as I could expect. And now having seen how the Poles, Axis, Equator, and Parallels in the Sun altered their Appearances to the Eye placed on the Earth, according as she changed her place in her Orbit, this put me upon considering how the Axis of the Earth, and the several Paths, or Parallels imagined on it, would appear from the Sun, and how the Diurnal *Phænomena*

would

would be represented by an *Orthographical* Projection of our Globe, on a Plane standing at Right-Angles to the Ecliptick, and the Line connecting the Centers of the Sun and Earth: Here I found what I have delivered in the first *Section* of the Second Part of this Treatise, *viz.* how the Parallaxes of Altitude, Longitude, and Latitude, were made, and given by Construction, and upon a little farther Consideration, how the Times of any Appearance of a Solar Eclipse, the parts then darkned, with the Inclinations of the Cusps might be determined, without any Calculation of them, by the help of such a Projection. Much pleased with this discovery, I immediately constructed an Eclipse I had observed at *Derby*, *Octob.* 25. 1668. and with a brief Description of the Method transmitted it to my kind Friend, and then Living Patron Sir *Jonas Moore*, by whom it was Communicated to the Royal Society at one of their Meetings; It happened Sir *Christopher Wren* was there present, who having viewed the Figure only, told him, that himself had known the same Method 16 years agone, and to assure him of it, sent him soon after a like Projection neatly drawn on Pastboard, and fitted with several Ingenious contrivances of Numbers and Scales for the Construction of Solar Eclipses in our Latitude. This Sir *Jonas* brought down to me, then Labouring under some Distempers, to *Greenwich*, whereby I was satisfied that the honour of the first Discovery of this useful invention was absolutely due to Sir *Christopher Wren*, whom of all Mortals I believe to have been the first, that knew how to find the Times of the Beginning, Middle, Digits then darkned, Inclination of the Cusps at any Phasis, and End of a Solar Eclipse, without the Calculation of Parallaxes.

In

In some Discourse I had with Mr. *Halley*, before he went to observe the Southern Constellations at St. *Helena*, he Mentioned the Construction of Eclipses as possible, but out of a tender Affection to his own Inventions, or for what other Reason I know not, he was pleased to conceal his Method both from me, who then thought it scarce possible, and, for ought I can understand, from all others: Nor is it to be wondred at, that three of us should make this discovery severally, and without any Intimation of the Method from each other; For to me it seems very unlikely, that any one who admits the Motion of the Earth, and apprehends how the Moon passing betwixt the Sun and it, Eclipses some part of him to all those People who lie under its passage, should ever miss of it. But we might rather admire, (had I not intimated the Reason of it in the fifth *Section* of the Second Part) that the acute Wit of the Sagacious *Kepler* should over look it, when he had discovered the Method of finding by Calculation within what spaces on our Globe the Solar Eclipse is bounded, and where the principal *Phases* of it would appear. p. 54

I had almost finished what I have here delivered concerning the Construction of Eclipses, when it was intimated to me by my kind and Ingenious Freind Mr. *Perkins*, that there was little extant in the *English* Tongue concerning the general Method of Calculation aforementioned, and that therefore I might do well to explain it. I considered then that this might be performed more easily than is Taught by the first famous Inventer, and without his Nonagessimary Table. Waving therefore my first intent, which was not to engage my self in any thing, that had been expresly handled by others

others before me; I thought it necessary to impose this farther task on my self, and accordingly wrote the precepts relating to that Subject, after, tho for Method sake, they are inserted before the Construction of the Solar Eclipse.

In the year 1670. I first published Predictions of the Moons Appulses to Fixed Stars, which I continued Eight years after successively, first in the *Philosophical Transactions*, after in the *Royal Almanack*, proposing them as an useful and the most practicable expedient for finding the *Longitude*, or difference of Meridians betwixt any two places, by reason both of their frequency, and that a single Person might obtain what ever is required in Observations of them with a small *Apparatus* of Instruments, but the Calculation of Parallaxes required in their Application caused them to be less regarded then I hoped they would have been; I have therefore shewn here how this tedious labour may be avoided, and the Occultation or Emersion of a Star from the Moon, or the Time of its visible Conjunction with her Center, and distance then from her next Limb may be found by Construction, as the *Phases* of a Solar Eclipse; and the difference of Meridians betwixt two distant places, by Observations of the same Appulse made at each; and now the main difficulty being removed, I would again recommend this Method to the Study and Practice of the Ingenious *Astronomer* and *Navigator*.

Whom I advise to make himself well acquainted with the first part of this following Work, if he intends throughly to understand the second, wherein the Method of Constructing Eclipses and Appulses is Taught. And to carry this Notion along with him, which I forgot to insert in his proper place, *That by the true distance of the Sun or a Star from the Vertex*, I mean *an Arch in the*

Earths

Earths ſuperficies intercepted betwixt two Lines produced from its Center, the one to the ſtation of the Obſerver, or Vertex, the other to the Sun or Star. Something may after appear difficult, eſpecially to ſuch Young Artiſts, as this piece is properly deſign'd to Inſtruct, though I have endeavoured to be as plain as was poſſible; but where there are ſuch able Maſters as Mr. *Perkins* to explicate them, ſome little difficulties will be found rather an advantage, than otherways to the Student.

The aforementioned Predictions of Appulſes gave occaſion to my firſt acquaintance with Sir *Jonas Moore*, who well apprehending their uſe, and that good Obſervations of the Moons Motions conſtantly continued for ſome years, and an accurate Catalogue of the Fixed Stars were required, before this eaſy Method was to be applyed, was pleaſed to recommend me for that Work to his MAJESTY, who has ſo far encouraged it by his Liberal allowance, that we need not doubt but what is wanting may be obtained in reaſonable Time. And now Sir *Jonas* having left a Book of *Navigation* in the Preſs, by reaſon of his ſudden Deceaſe, unperfect, I thought I could not at preſent better anſwer the Engagements I lie under to my Royal, and moſt Gracious Maſter, than by imparting to the Publick an Invention, which through his Favour and Princely Care may become of ample uſe to it, in a piece deſigned by the Author for his peculiar ſervice. In doing of which I hope I may be allowed to have ſatisfied the intereſt of that debt of Gratitude I owe his Memory, and that the diſcharge of the Principal will be Reſpited, till ſuch time as Providence ſhall enable me with a more proper occaſion, which I hope may be e're long.

THE CONTENTS.

PART I.

PART II.

AN Orthographical Projection of the Globe, Sphere, or Rete, on a Plane touching the Moons Orbit, at Right Angles to the Line Connecting the Centers of the Earth, and Sun, or given Star, by infinite streight Lines proceeding from either to the Rete or Sphere is Taught, and Described; and the Moons Parallaxes in Altitude, Longitude and Latitude, determin'd by it only. Sect. 1.

The Breadth of the Semidiameter of the Disk, Penumbra, and Earths shadow demonstrated, how the Eclipse of the Sun is made. Sect. 2.

How the true Places of the Sun and Moon, her Latitude, Horary Motion, Horizontal Semidiameters, and Parallaxes may be found by Calculation, by Tables annexed to this Treatise fitted to the Meridian of London, *with Examples, the Author discovers the greatest Error of the said Tables.* Sect. 3.

How by the said Tables to find the Times of the Mean and True Conjunctions or Oppositions of the Luminaries, as also of the Principal Phases of a Solar Eclipse under the Meridian of London, *with the Longitudes of the Places from it, and their Latitudes where the said Phases shall appear, that is,*

1. *Where the Eclipse Begins in the Sun's Vertex as he Rises.*
2. *Where it Ends in his Vertex, as he Rises.*
3. *Where he Rises Centrally Eclipsed.*
4. *Where he Sets Centrally Eclipsed.*
5. *Where the Eclipse Ends in the lowest Point of the Rising Sun.*
6. *Where it Begins in his lowest Point as he Sets.*
7. *Where the Sun is Centrally Eclipsed in the Meridian.*
8. *Where the Suns lower is just touched by the Moons upper Limb in the Meridian.*
9. *Where his upper is just touched by her lower Limb in the Meridian.*
10. *Where the Sun is Centrally Eclipsed in the Nonagesime, without the help of any Nonagesimary Table, exemplified in the Eclipse of the Sun happning July the 2d 1684.* Sect. 4.

The Reason and Demonstration of the said Calculus; A Time at London *given, to find the place where the Sun shall then appear Centrally Eclipsed, and Time at that place.* Sect. 5.

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The remoteness of my habitation from the Press, has been the principal accasion of the following *ERRATA*, which the Reader is advised to Correct before he proceed any further.

PAge 1. Line 19. for *Contiguation*, read *Configuration*. p. 2. l. 23. for *Chartes*, read *Cartes*. p 3. l. 15. for *Vertex*, read *Vortex*. l. 26. for *Declination*, read *Delineation*. p. 4. l. 45. for *P c*, read *P C a*. p. 9. l. 15. for *q T s a*, read *q T w*. l. 28. for *the place*, read *that place*. p. 10. l. 12. for *c s*, ♋ *o*, read *c, s* ♋ ☉. p. 11. l. 1. for *s, o P*, read *s*, ☉ ♋. l. 10. for *Chapter*, read *Section*. p. 17. l. 5. for ½ *c s*, read ½ = *c a*. pag. 18. l. 32. for *y n a*, read *y n s*. p. 20. l. 31. *put the Comma after* c. l. 34. for *N*, read *8 N*. p. 24. l. 5. for *by Copernicans*, read *by the Copernicans*. p. 27. l. 7. for *Phases*, read *Phases*. p. 30. l. 1. for *H*, read *r*. l. 3. for *b*, read *H*. p. 31. l. 31. for *T ω*, read *T a*. p. 33. l. 8. for ☉ *c T*, read *o C T*. p. 35. l. 5. for *Added or*, read *Added to, or*. p. 40. l. 39. for *Solar shadow*, read *Solar, of the shadow*. p. 45. l. 25. *Blot out the Comma after Diameter*. l. 32. for *happens*, read *appears*. p. 46. l. 8. for *makes*, read *it makes*. p. 47. l. 15. for *Disk she*, read *Disk when she*. p. 48. l. 10. for *that Pa b*, read *the Path*. p. 50. l. 1. for *the Latitude*, read *that Latitude*. p. 58. l. 24. for λ, read *ω*. p. 59. l. 1. for *s*, read χ. p. 72. l. 14. *after Parallax add*, + *the Sun*. p. 74. l. 41. for *of Greenwich*, read *at Greenwich*.

Errors to be amended in the Tables. Pag. 80. *against Feb.* 2. for 1 2 31 25, read 1 02 31 35. p. 81. *against Aug.* 4. f. 7 02 53 59. r. 7 02 53 49. p. 86. *against Feb.* 12. f. 2 16 47. r. 2 16 37. *and against Feb.* 13. f. 2 19 08. r. 2 29 48. p. 88. *against May* 19. f. 1 01 38 08. r. 1 01 31 08. *and against May* 15. f. 15 02 24. r. 15 02 22. *and against May* 11. f. 6 56 18. r. 6 56 14. p. 90. 4th *Column after Feb.* 28. *put in* 29 30 31. *and against* 30. *for* 11 02 26 35. r. 11 02 26 51. p. 92. *against* 29. *Dec.* f. 59783. r. 49783. *and against* 30. f. 59429. r. 49429. p. 97. *against* 5, 23. f. 0 49 30. r. 0 49 40. p. 104. *against year* 1. f. 6 28 38 29. r. 6 24 35 29. *and against* 2 *days* f. 4 24 22 53. r. 0 24 22 53.

Those are corrected.

THE

THE DOCTRINE OF THE SPHERE.

SECTION I.

THose who have converſed with Antiquity will eaſily allow the *Pythagorean* Syſtem of the World, lately revived by *Copernicus*, to have been Compoſed long before the *Ariſtotelian*; which though it had the Fortune to be more generally entertained, and to be adorned with very ſpecious Explications by *Ptolemy* and his Followers, will force who ever ſhall go about to defend it, on ſuch Aſſertions, as no ingenuous man could ever conceive to be reaſonable: For what perſon who has been ſo far acquainted with Aſtronomical Demonſtrations, as to underſtand how vaſtly bigger then our Earth, not only the Sun, but ſome of the Planets alſo are, how immenſly diſtant from us the fixed Stars are placed, and that ſome of them are probably bigger than the Sun it ſelf? What man I ſay, thus informed, could ever conceive, that all this great Contigyation ſhould be thrown about ſo ſlender a Ball as our Earth is, n

compared with them, once in Four and twenty Hours? which the *Aristotelians* are forced to affirm. And how could it sink into the conception of a considerate man, that Nature or the unrestrained Architect of the Heavens should contrive *Epicycles* and contrary Motions to carry about the same Body, as they are likewise obliged to assert, when whatever is to be performed by them, might much more easily be effected by one continual progressive Motion of each Planet in a simple Line, as is abundantly proved in the Works of the Learned *Kepler*, and by the near agreement of his Tables with Celestial Observations, whilst the Planets places calculated from the best Numbers extant, grounded on the *Ptolemaick Hypothesis*, are found as wide and different from their observed Positions, as that *System* is from the *Copernican*?

The Noble *Tycho* proposed a third *System*, which as a Mean betwixt these, he thought might find the easier entertainment in the World: In this he admitted the Diurnal Rotation of the Earth about her *Axis*, whereby he avoided the imputation of that absurd Opinion, That the Sun, and with him all the Planets and fixed Stars were carried round her once a day; but the Sun and all the other Planets, save the Moon, moving round him, he supposed carried about the Earth once in a year. By this contrivance he conceived he attributed less Motion to the Earth than the *Copernicans*; and that nevertheless the appearances of the Planets would be represented, as in that *Hypothesis*: But if we may admit the Philosophy of the very ingenious *Des Cartes*, it will be found, the Motion he allows the Earth is not less, but as much or more than the *Copernicans* require; and it seems little less difficult to conceive, that the vast Bodies of the Sun and Planets should be carried about it Annually, than Diurnally. However this Opinion has found but very few Followers, those who with *Aristotle* and his Disciples deny the Motion of the Earth, being unwilling to grant so much, as the noble Restorer of *Astronomy* required; and those who, with *Pythagoras* and his *Sectators* the *Copernicans*, admit it, thinking it no less necessary to assert the Annual, than the Diurnal.

Tycho did not admitt the Diurnal rotation of the Earth, but Oryanus and Longomontanus did.

But the great and many Discoveries which have been made in the Heavens by the means of the *Telescope*, invented some few years after the decease of this Famous and never enough commended Great Person, have put an end to the Controversie in the opinion of all Ingenuous and unprejudiced Judgments, by affording as near as many Arguments for the Earths Motion, as they are in Number. It would require an intire Volume to give an account of all, and what may be inferred from them: I am obliged to brevity, and shall therefore mention no more but the following. The Planet ♃ is allowed by all Astronomers to be carried round the Heavens once in Twelve years, though he be very considerably larger then our Globe of Earth; and when nearest, five times more remote than it from the Sun: This Planet nevertheless is found by undoubtable Observations, to turn about his own *Axis* once in some little less than Ten Hours, which I conceive so plain an Argument, both for the Annual and Diurnal Motion of the Earth, that the *Copernicans* need

not seek any other, till their Antagonists shall produce a better for its stability.

How the Annual appearances of the Planets, their accelerate and retarded Motions, the augmentation and decrease of their visible Magnitudes, together with their Stations, and Retrogradations, are formed in the *Pythagorean* or *Copernican System*, has been abundantly shewed us by those many Learned Persons, who have framed Astronomical Tables on it, for calculating the Planets Places in the Heavens: But how the Diurnal are made out, none that I know of, hath fully informed us. Having therefore obliged my self by promise to the Relations of my deceased kind Friend, the great Encourager of my Studies, and the Author of the foregoing Work, to write an Explication of the *Phainomena* of the *Globe*, which was wanting in it: I shall ground it on that oldest and true *System*, which asserts the Sun to be placed in the Center of our *Vortex*, and all the Planetary Motions (having none proper to himself, besides a *Rotation* about his own *Axis* once in 25 days 9 hours nearly) and then,

1. That the Earth is carried round the Sun in a large Path, betwixt the Orbs of ♂ and ♀ once in a year.
2. That besides this Annual Motion, she turns round her own *Axis* once in 24 hours.
3. That the said *Axis* is constantly inclined to the Plane of the Orb at the same Angle, and keeps in all parts of the same Revolution, nearly parallel to it self.

These Assertions being the ground on which the following Discourses are founded, it will be convenient to explicate them by a Plane Declination; in doing of which, I shall also take occasion to explain some terms, whereof I shall make frequent use hereafter.

Section II.

IN the uppermost of the two first Figures, let ☉ represent the *Sun* placed near the Center of the Annual Orb A B C D, in the *Periphery* of which the Earths Center is carried round him once a year, according to the Succession of the Signs. The Ancients, and all before the Sagacious *Kepler*, supposed this a perfect *Circle*, but he proves it to be an *Ellipsis*, the remotest end of whose longer or transverse Diameter, is Eight Signs, and nearly as many Degrees elongated from the first Star of ♈, and having the Sun in one of its focal Points.

Through ☉ the Sun draws the Line ♈ ☉ ♎, this I call the *Equinoctial Colure*; and at right Angles to it, also through the Sun ♋ ☉ ♑, this I term the *Solstitial Colure*.

On the Centers *a* where these Lines intersect the Annual Orb, describe the four lesser Circles *d e f g*, these may represent the places of the Earths

Globe, on its four Cardinal Points; and if through *e* in each of these, the Lines *d t*, be drawn at right Angles to ☉ *e*, these shall determine the illuminate part of the Diske *d i t*, from the obscure *d v t*; wherefore I term the Lines *d e t*, *the Horizon of the Diske*.

If the plane of the Annual Orb A B C D, be supposed produced from the Sun infinitely every way, it will describe amongst the fixed Stars that Line we call the Ecliptick: And if in any place of the Orb, the Eye be supposed, somewhere in the inferior Hemisphere of the Earth, perpendicular to the Ecliptick, over her Center, then shall the utmost Circle of the Earths superior Hemisphere *d o t i*, lye in the same plane; and therefore I call it the *Ecliptick on the Earths Globe*, or, when I have no occasion to consider the Annual Orb, simply the *Ecliptick*; and its Center *e*, the *Center of the Ecliptick*.

To the Eye thus placed, the Northern Pole of the Globe, or the upper Extremity of that Axis, about which her diurnal Revolutions are made, will appear at P 23° 29′ distant from the Pole of the Ecliptick, to which if it be joyned by the Line P *e*, this shall represent the constant distance of the two Poles, or the inclination of the Axes of the Globe and Ecliptick to each other; we may call it *the Line of the Direction of the Earths Axis*.

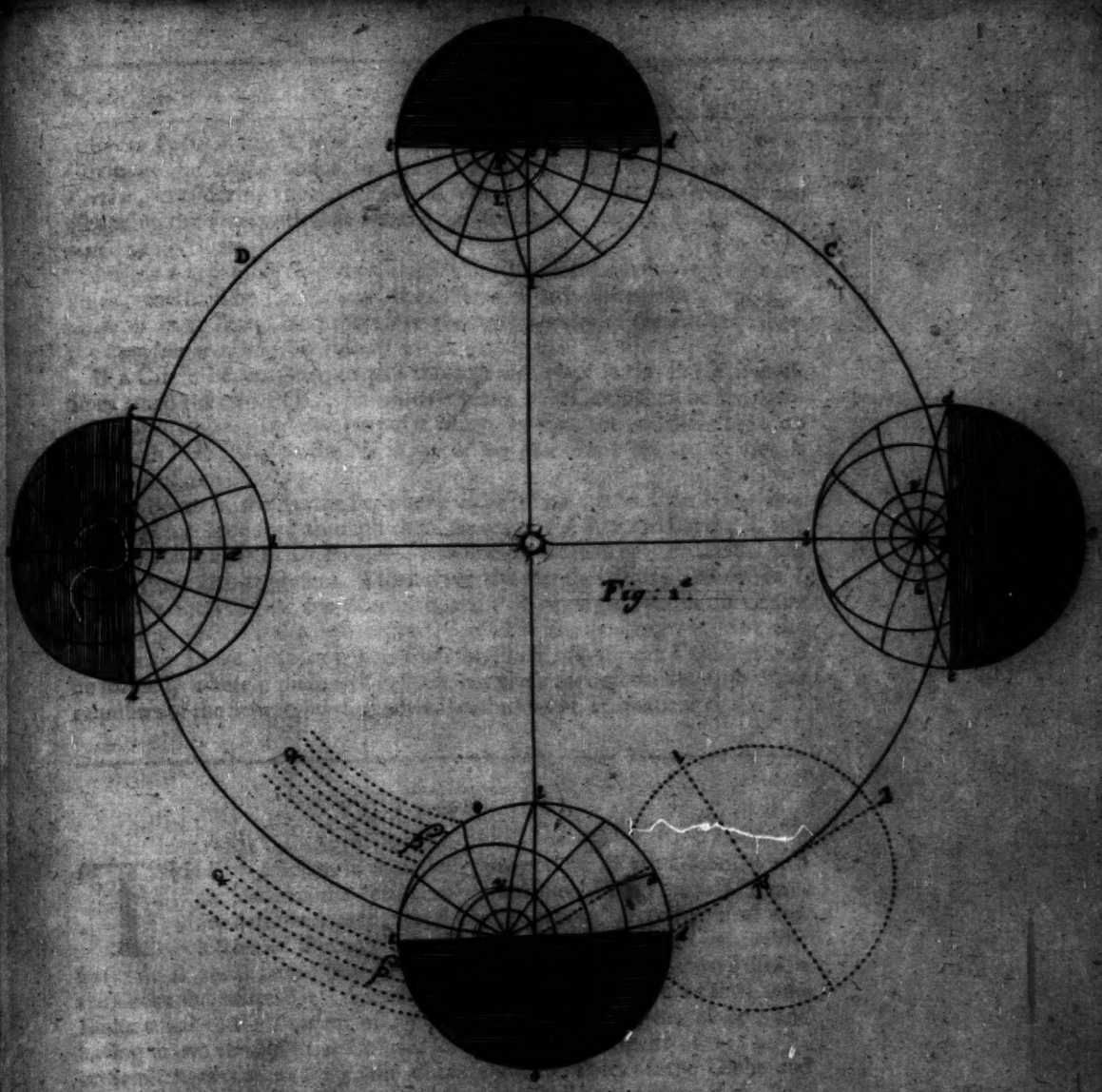
Let this Line be produced each way till it intersect the Ecliptick on both sides; so have you that Line in the Diske, I call the *Solstitial Colure*; because when ever the direct Rays proceeding from the *Sun's* towards the *Earth's* Center, run parallel to this Line, that is, when the Earths Center shall be found in the *Great Solstitial Colure* ♋ ☉ ♑ before described, the longest or shortest Days are made in all places on it.

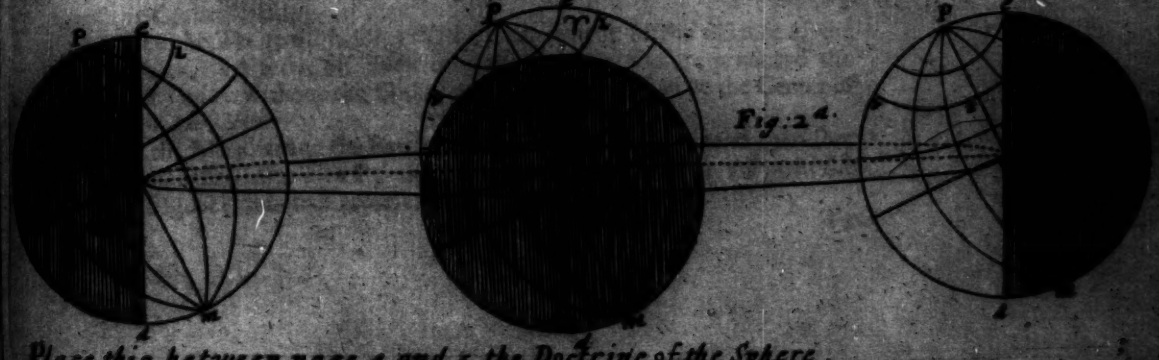
This Line of Direction P *e* is found allways parallel to the *Great Solstitial Colure* ♋ ☉ ♑, and nearly to it self where ever the Earth is found in her Orbit, dureing the space of *one Annual Revolution*.

That Line which stands at right Angles to the Line of direction on the Center *e*, we may call the *Earths Equinoctial Colure*; because it keeps always parallel to the great Equinoctial Colure before described, and when ever the Suns Centrall Rays incede directly parallel to it, the Days and Nights are equall in all places: And this also happens when the Earths Center arrives at the Points, where the *Great Equinoctial Colure* intersects the Orbit.

The Inclination of the Axis will be best apprehended by the under
C Figure, in which the Line C ♈ C C, may represent the great Orb, viewed by the Eye from an infinite distance, some little elevated above its plane ♈ ♋ ♎ ♑, the Earths positions in it on the four Cardinal points, *e* the Pole of the Ecliptick, *e d* its Axis, always perpendicular to the great Orb, over the Earths Center, P the North Pole of the World, P *m* its Axis, about which the diurnal revolutions are made from West to East, keeping in all parts and places of the Orbit during one revo-
C lution, nearly parallel to its self; the Angle of its inclination to the Axis of the Ecliptick P *e* being constantly 23° 29′, and for ought we can collect from the ancienteſt Celestial observations, remaining in all Ages invariable.

Every





Place this between page 4 and 5 the Doctrine of the Sphere.

Place this between Pages 4 and 5 the Description of the Spheres

Every Point in the Globe as it turns round upon its Axis describes a Circle in the Diske about the next Pole, which I call *the Path of the Vertex*, considering the said Point as Vertical to the Earths Center: its uses being the same with that we call the Zenith, or Vertex, in the *Ptolemaick* projections.

Imagin a great Circle compassing the Earth equally distant from both its Poles, this shall be the *Equator*, the distance of any place from it the *Latitude of that Place*, and therefore the *Semidiameter of the Path* equal to the *Complement of the Latitude*.

If a Circle be imagined to pass through any place in the Earths superficies, and the two Poles, on which it turns, that Circle shall be the *Meridian of that place*; and that part of it which lies from the said place towards the North Pole, will be the *North part of the Meridian*; toward the South Pole, *the South Part*.

That Point in the Earths Periphery opposite to the Sun, or lying in a straight Line produced through the Centers of the Sun and Earth, I call *the Suns place in the Ecliptick*. And now seeing we shall have no farther use of the great Orb at present, I shall wave the mention of it; and when I shall have shewed how the Meridian, and *Path* of any *Vertex* in the Globe may be projected, the Eye being supposed in the Southern Pole of the Ecliptick; I shall next shew how from this Point, Spherical Triangles will be formed, wherein there will be sufficient given for determining the usual requisites of the Sphere, by the known Resolutions of Trigonometry.

SECTION III.

THE Meridians in those lesser projections of the Globe, which are placed in the Periphery of the Annual Orb in the first Figure, are described as the hour Circles in that Stereographical projection of the Sphere on the Plane of the Horizon; where the Latitude is equal to the Complement of the Distance of the two Poles of the Globe and Ecliptick; that is thus, make the Semidiameter of the Earths Diske equal to the Tangent of 45 Degrees, or Semitangent of 90, and having drawn the Solstitial Colure, set off in it the Tangent of 11° 44′ ½, or Semitangent of 23° 29′, the distance of the Poles of the Globe and the Ecliptick, from the Center *c* to P; that shall be the place of the Pole of the Globe. Fig. 3.

Take the Tangent of 66° 31′, the Complement of the distance of the two Poles, and set it off likewise in the Solstitial Colure produced the contrary way, without the Diske, from *c* to T, this shall be the Center of the *first Meridian*.

All the Meridians on the Earth pass through its Poles, extend therefore the Compasses from T to P, and through it strike the Arch ♈ P ♎ in the third Figure; this shall represent the said *first Meridian*.

To

To find the Centers of all the rest, through T draw γ T ϒ at right Angles to the Solstitial Colure produced, and making TP the Radius of a Tangent Line, therewith divide the said Line both ways from T.

Fig. 3. Count 15, 30, 45, 60, 75 Degrees in the said Line both ways from T; so have you the Centers of ten other Meridians, upon each of which, if you set one Foot of the Compasses, and extending the other to the Pole P, therewith describe Circles through it, these shall represent so many Meridians, each one hour distant from other, or the Hour-circles, the Earth being in the first Point of ϒ or ♎, and viewing the Sun in the opposite Point.

The last of these ☊ P ☋ coincedes with the Solstitial Colure, and is a streight Line, its Semidiameter the Tangent of 90 Degrees being infinite.

Every place or Point on the Globe, as I said before, describes a Circle about its Axis, which I call the *Path of the Vertex*. Let it be now required to delineate the Line, that *London* carried round the Axis describes on the Plane of the Ecliptick, to the Eye placed in its Southern Pole.

The distance of *London* from the Pole of the World is 38° 29′, and of the Pole of the World from the Pole of the Ecliptick 23° 29′: Let now in the third Figure ϒ ☊ ♎ ☋ represent the Periphery or Diske of the Earth lying in the Plane of the Ecliptick, ϒ the Pole of the Ecliptick, ☊ P ☋ the Solstitial Colure, ϒ ♎ the Equinoctial Colure, P the Pole of the Globe, set off in it according to the former directions.

To the distance of the Poles P ϒ 23° 29′, add 38° 29′, the distance of *London* from the North Pole of the Globe, the Sum 61° 58′ is the greatest distance of *London* from the Pole of the Ecliptick.

Make the Radius of the Diske equal to the Tangent of 45 Degrees, or Semitangent of 90; and from the same Line of Tangents, set off the Tangent 50° 59′, or Semitangent of 61° 58′ from ϒ the Pole of the Ecliptick, towards ☊ to *m*, in that Point the Path shall cut the Colure; or counting the said 61° 58′, from ϒ towards ☊ to M, in the Ecliptick, lay a Ruler over the oppoite Point ♎ and this Point M, it will cut the Colure in *m*, where the Path shall likewise intersect it.

Subtract the distance of the two Poles ϒ P 23° 29′, from the Complement of the Latitude 38° 29′, the Difference 15° 00′, is the nearest approach of the Path of the Vertex to the Pole of the Ecliptick.

From the forementioned Line of Semitangents, set off the said 15° 00′ from ϒ towards ♈, to *x*, or counting the said distance from ϒ towards ♈ to X, lay a Ruler over X and ♎, it will cut the Solstitial Colure in the said Point *x*, where it is intersected by the Path.

The Middle betwixt these Points *m* and *x*, shall be the Center, upon which if you strike a Circle through them, it shall be that Line I call the *Path of the Vertex*, or which *London* would appear to describe on the Plane of the Ecliptick, to the Eye placed in the Southern Pole, as the Earth turns round, if the Globe were diaphanous.

After

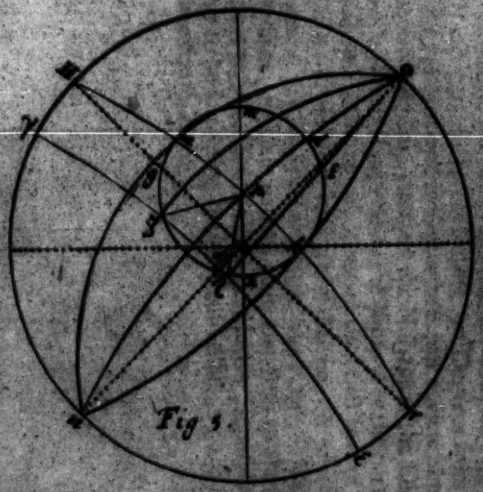
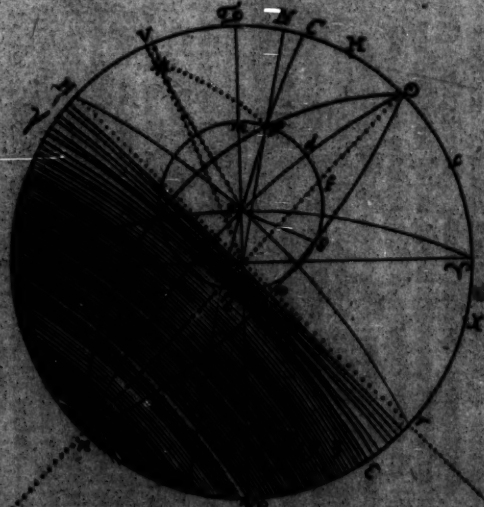


Fig 3.



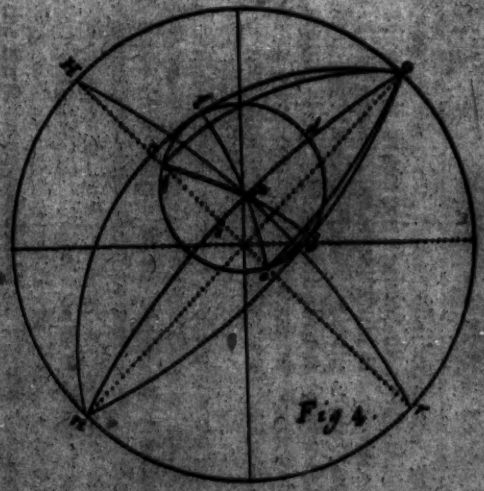


Fig 4.

Place this between page 6 and 7 the Doctrine of the Sphere.

After this manner were the Paths described in the small Projections placed in the Periphery of the first Figure, of which the remotest represents one half of the *Equator*, or of the Paths of such places as lie under it, that within this, the *Northern Tropick*, or the intire *Path* of such places as lie in the Latitude of 23° 29' North: the next within this is the Path of *London*, or of any place equally distant from the North Pole of the Globe; the innermost, of such places as lie 23° 29' distant from the said Pole, which therefore we may call the *Arctick Circle*.

Whereby it will be easily conceived, why under the Equator the Days are equal at all times of the year; why the Days at the same time of the year are not of the same length in all places, why within the Arctick Circle they are sometimes longer than 24 hours, and at the opposite times of the year the Nights as long; but when the Earth transits the first Points of ♈ and ♎, the Days and Nights are in all places equal.

For the Sun illuminates but one half of the Earths Globe by his Central Rays, and if the Earth be supposed at ♈ or ♎, the *Horizon of the Diske* and coincides with the *Solstitial Colure*; and of all the Paths which can be projected within the Ecliptick, on the Globe, according to the foregoing precepts, the one half will fall in the illuminate, the other in the obscure part of the Diske. Now whilst the *Vertex* is traversing the illuminate part, it sees the Sun, and we call it *Day*; whilst it travels through the obscure, we see him not, tis *Night* to us; and since in both these positions of the Globe, the obscure parts of all the *Paths*, or the *Nocturnal Arches*, will be equal to the illuminate, or *Diurnal Arches*, the days must of necessity be equal to the Nights in all places.

Conceive the Globe to have moved from ♈ to ♎, *the Line of Direction*, (keeping its *parallelism* to its self, and the *prime Solstitial Colure*) now coincides with it, and the Rays of the Sun illuminating the Hemisphere, and the Horizon of the Diske stands at right Angles to it, on the Pole of the Ecliptick: Here all places between the two Poles of the Globe, and Ecliptick, or within the Arctick Circle, are illuminated in their whole Revolutions. Wherefore the *Vertexes* see the Sun longer than 24 hours, more or less according as they are less or more distant from the Pole of the Globe, but those which lie under the Arctick Circle touch the Horizon of the Diske; and therefore at this time see the Sun, not only in the South, but also in the North part of the Meridian, 90 Degrees from the Vertex, or precisely in the Horizon, and as soon as he is past it, view him rising again.

All the *Paths*, without this, intersect the Horizon of the Diske; whereby the *Day* is made so much longer than the Night, as the part of the Path lying in the *Illuminate Hemisphere*, is more than that part of it which lies in the *obscure*; *v z d* represents the *Path of London*, in which the *Vertex* cuts the *Horizon of the Diske*, some little more than 8 hours before it transits the *Meridian*, or Line passing from the Pole to the Sun, and tis so long again ere it pass the Horizon into the obscure Hemisphere; thereby shewing the *Day* to be something longer than 16 hours, and therefore the *Night* at this time scarce eight.

Whilst

Whilst the Earth runs from ♎ by ♑ to ♈, the *Northern Pole* will be always in the illuminate part of the Diske, thereby shewing that it is continual Day all that time under the said Pole, but whilst she runs from ♈ by ♋ to ♎, it will lie in the obscure part, thereby shewing it continually Night in the same place; the South Pole in the mean time passing in the illuminate Diske, and enjoying the Day, as it did the Night continually whilst the North Pole was illuminate: So that *under the Poles, the whole year consists but of one long Day, and Night.*

When the Earth is at ♋, whence the Sun appears in ♑, the length of the Night will be equal to the length of the Day when the Earth was on the opposite Point; for the *Nocturnal Arch*, or obscure part of the Path, is here equal to the illuminate, or *Diurnal*, when the Globe was at ♑, and the illuminate here no more than the obscure in that place.

When the Earth is at ♑, the *Tropical Path* will just touch the Ecliptick in the Meridian, or that point of the illuminate Diske, which is directly opposite to the Sun, thereby shewing that when ever the Earth arrives at that Point of her Orbit, the Meridional Sun will be vertical to all places in that Latitude of 23° 29′ North, the length of the Day here appears by the Projection, for the illuminate part of the Path betwixt the Horizon and Meridian being something less than 7 hours, the intire Day must be something less then its double, or 14 hours, and therefore the Night above 10 hours.

But to those People who live upon the Equator, the one half of the Path will always fall in the illuminate part of the Diske, the other in the obscure; to whom therefore at all times of the year, the Days and Nights will be equal.

How the Paths lie that have the same Latitude South of the *Equator*, will be easily seen, if the first Figure be held before a Looking Glass, and its Picture viewed in it; or they may be projected *in plano*, if ♋ be wrote where ♑ is, ♈ where ♎, *&c.* in the great Orb, and the Pole of the World laid down on the contrary side, or to the right hand; from the Pole of the Ecliptick: I shall not need therefore to repeat any directions for this purpose, but only to shew how such further Lines as shall be found necessary for my business in hand, may be described, and how the common requisites of the Sphere may be investigated by them.

SECTION IV.

THE first thing supposed to be known in all Problems concerning the diurnal *Phænomena*, is the distance betwixt the two Poles of the Globe and Ecliptick; this I have before proposed 23° 29′.

The next is the *Sums* place, or the Longitude of the Point in the Earths Diske opposite to him, from the next Equinoctial Point. And these being given, the requisites demanded are of two sorts; General;

or

or Particular, the General are such as are the same to all the inhabitants of the Globe, at the same time, as

1. The distance of the Suns place from the North Pole of the Globe.
2. The right Ascension of the said place.
3. The Angle which the Meridian passing through it makes with the Ecliptick.

The Particular are such as are different at the same time in different Latitudes, such are the Amplitudes, and Ascensional Differences, &c. which require the knowledg of the ☉ distance from the Pole, to limit them. I shall therefore first shew how the General requisites may be represented and determined, supposing the ☉ place in 15 Degrees of ♉, or 45 Degrees distant from the first Point of ♈.

In the third Figure, let ♈ S ♎ ♑ represent the Ecliptick, e its Pole, ♋ e ♑ the Solstitial, ♈ e ♎ the Equinoctial Colure, P the North Pole of the Globe, ♈ P ♎ the first Meridian described, and q T 2b, the Tangent Line passing through its Center, divided according to the Prescriptions of the foregoing Chapter. Fig. 3.

Count 45 Degrees, the ☉ distance from the Equinoctial, from ♈ towards ♋ to ☉, through which and the Pole of the Ecliptick e, draw the *Line of the Suns Longitude* ☉ e n, producing it till it intersect the Tangent Line in q.

Through e draw H e r, at right Angles to ☉ e n, this shall be *the Horizon of the Disk* to this place of the Sun, beyond which produce it likewise, till it intersect the Tangent Line in w.

Setting one foot of the Compasses on w, extend the other to the Pole P, with this extent you may strike the Arch n P ☉, which shall intersect the Ecliptick on both sides, with the Line of Longitude in ☉ and n, this shall be the *Proper Meridian* to the place of the Sun.

In like manner on the Center q, with the distance P q, you may strike the Arch H P r, which passing through the Pole shall intersect the Horizon of the Disk on both sides, where it cuts the Ecliptick; this shall cut the *Proper Meridian* at right Angles in the Pole, and is therefore the *Six a Clock Hour-circle* to that place of the Sun.

Conceive both the *Colures*, the *First*, and *Proper Meridian*, the *Hour-circle of Six*, together with the *Path of the Vertex*, and in General all the Lines hereafter to be described as a *Fixed Rete*, close investing the Earth whilst she turns round within them.

And now betwixt the *Proper Meridian*, the *Ecliptick*, and *Solstitial Colure*, we have formed the Spherical Triangle ♋ P ☉, right Angled at ♋, wherein we have given ☉ ♋, the Complement of ♈ ☉ the Suns distance from the Equinoctial 45° 00′; ♋ P, the Complement of P e, the distance of the Poles of the Globe and Ecliptick 66° 31′; with the Angle at ♋ *Right*, to find, 1. P ☉ *the Suns distance from the Pole*, 2. ♋ P ☉, the Complement of ☉ P ♈, *his right Ascension from* ♈, and 3. P ☉ ♋, *the Angle of the Meridian passing by the Sun with the Ecliptick*. For the first, or P ☉, by the demonstrated properties of Spherical Triangles, it will hold,

R. cs, ☊☋ :: cs, ☋P. cs, PO or

	°	′	″	Log.
As the Radius,	90	00	00	10,000000
To the Sine of the two Poles Distance;	S. 23	29	00	9,600409
So the Sine of the ☉ Longitude from the Equinox:	45	00	00	9,849485
To the Co-sine of his Distance from the next Pole:	73	28	02	29,449894

Whole Complement P*i*, 16° 21′ 57″, is the Distance of the *North Pole* from the *Horizon of the Disk*, or the *Reflection* equal to the ☉ *Declination* in the *Ptolemaick Systeme*.

The ☉ *right Ascension* is that Angle at the Pole, which the proper Meridian ☊P forms with the first ♈P, its Complement ☊P♈ will be found in the aforementioned Triangle, by this proportion,

R. *i*, ☋P :: cs ☋☊, cs ☊P♈, wherefore it will hold,

	°	′	″	
As the Radius,	S. 90	00	00	10,000000
To the Co-sine of the Distance of the two Poles,	23	29	00	9,962453
So the Tangent of the ☉ Longitude from the next Equinoctial Point,	45	00	00	10,000000
To the Tangent of his right Ascension from the said Point,	42	31	35	29,962453

If the Sun had appeared in the middle of ♋, where he is equally distant from the first Point of ♈, this Arch subtracted from 360, the right Ascension of the last Point of the Ecliptick, had given his right Ascension there 317° 28′ 25″.

If he had appeared as far remote from the opposite Equinoctial Point, either in the middle of ♌ or ♍, this Arch Subtracted from 180 Degrees, the right Ascension of the opposite Point, had given 137° 28′ 25″ his right Ascension in the middle of ♌; added to 180, it would make 222° 31′ 35″, the same in the middle of ♍.

After this manner by the right Ascensions calculated only to one Quadrant of the Ecliptick, the same may be made out to every Degree of the whole.

For finding the third of the General Requisites, or the Angle P☊☋, which the proper Meridian makes with the Ecliptick, in the same Triangle we may say

As the Co-sine of the ☉ Longitude from ♈ or ♎,		45	00	00	9,849485
To a Radius;		90	00	00	10,000000
So the Co-tangent of the two Poles Distance,		23	29	00	10,362044
To the Tangent of the Angle of the Meridian and Ecliptick,		72	55	20	10,512559

SECTION V.

BEfore any other requisites can be investigated, the *Pole of the Vertex* or place to which they are required must be described, which may be done according to the directions of the third Chapter; this for *London* will be in the third and fifth Figure the Circle *xfmg*, by whose intersections with the six a Clock Hour-circle *ka*, and the Points ⊙ *a* strike two Arches of Circles, then to find the two first particular requisites, or,

Fig. 5. Section

The Suns distance from the Vertex at the hour of six,
The Suns Azimuth at the hour of six,

In the Spherical Triangles P⊙*k*, P⊙*a*, right Angled at P, are given P*k* = P*a*, the distance of the Pole from the Path, or the Complement of the Latitude 38° 30′; P⊙ the distance of the Sun from the Pole, found before 73° 38′ 03″; to find ⊙*k*, or ⊙*a*, the distance demanded; with P*k*⊙ or P*a*⊙, the Azimuth of the Sun from the North at the said hour; for the side ⊙*k* you may say,

R. *cs* P⊙ :: *cs* P*k*. *cs* ⊙*k*, or,

As the Radius,	*S.*	90	00	00	10,000000
To the Co-sine of the Latitude;		51	30	00	9,794149
So the Sine of the Reflection,		16	21	57	9,449894
To the Co-sine of the Suns Distance from the Vertex.		79	53	52	9,244043

And for the ⊙ Azimuth at six, or the Angle ⊙*k*P,

S. *k*P. R :: *cs* ⊙P. [illegible] ⊙*k*P, or,

As the Co-sine of the Latitude,		51	30	00	9,794149
To the Radius;	*S.*	90	00	00	10,000000
So the Tangent of the ☉ Distance from the Pole,		73	38	03	10,532143
To the Tan. of his Azimuth from the North Merid.		79	38	23	10,137994

For in what part of the *Path* soever the Vertex is found, that part of the Hour-Circle intercepted betwixt it and the Pole, is the *North part of the Meridian* in all North Latitudes; And therefore the Angle P *l* ⊙, formed betwixt it and the Line passing from the *Vertex* to the Sun, shall be his *Azimuth from the North Meridian*.

SECTION VI.

THerefore in what part of the Path soever it happens, that the *Meridian* shall be found to cut the Line passing from the *Vertex* to the Sun at right Angles, he appears due East, or West, or, as the *Ptolomaick* would phrase it, on the Prime Vertical.

Fig. 4. Let now two Arches of Circles ⊙ *b n*, ⊙ *l n*, be strook so, as they may pass through the two intersections of the Line of Longitude, and the Ecliptick ⊙ *n*, and but just touch the Path on each side it; the Points of Contingence at *b* and *l*, shall be the places in the Path from whence Hour-Circles strook through the Pole, shall intersect the Circles passing by the Sun at right Angles, in which therefore he shall appear due East or West; and now we have formed another pair of Triangles, (see the 4 Figure) P *l* ⊙ P *b* ⊙, in which we have sufficient given to determin

The Sun's distance from the Vertex when due East or West, and,

The time from Noon when he shall be so:

For in the said Triangles are given the Hypothenusa ⊙P, the Suns distance from the Pole of the Globe as before 73° 38′ 03″: the distance of the Pole from the Path P *b*, or P *l* 38° 30′ 00″: with the right Angles at *b* and *l*, to find ⊙ *b*, or ⊙ *l* the distance desired, or ⊙ P *b* = ⊙ P *l*, when he shall appear as required; for the first it will hold,

c s P *b* . R :: *c s* ⊙P . *c s b* ⊙, or,

As the Sine of the Latitude,	51	30	00	9,893544
To a Radius;	90	00	00	10,000000
So the Sine of the Reflection,	16	21	57	9,449894
To the Co-sine of the Suns Distance from the Vertex when due East or West.	68	53	50	9,556350

And for the latter,

t ⊙P . *t* P *b* :: R . *c t* ⊙ P *b*, or,

As the Tangent of the ⊙ Distance from the Pole,	73	38	03	10,532143
To the Co-Tangent of the Latitude;	51	30	00	9,900685
So is the Radius,	09	00	00	10,000000
To the Co-sine of the hour from Noon, when the Sun is due East or West.	76	29	28	9,368462
	h.			
Which is =	05	05	58	

SECTION VII.

THE Motion of the Earths Rotation about its Axis, is as hath been said from West to East, and therefore the Sun is then said to *Rise*, when the Vertex passes that Point in the Path at *o*, where it cuts the Horizon of the Disk; to *Culminate*, when it crosses the Meridian betwixt him and the Pole at *d*; and to *Set* when it passes over the other intersection of the Path and Horizon at *g*: Let the Arches of a pair of Hour-Circles be strook through the said intersection of the Path and Horizon, as likewise two others, through ⊙ *w*, and the said two Points; so shall there be two Triangles formed on each side the Meridian; that is, ⊙ P *o*, *o* P *i*, on the Oriental or ascending side, ⊙ P *g*, *i* P *g* on the occidental, in either of which we may find sufficient given, for determining the Suns Azimuth, Rising or Setting, and the time he Rises or Sets from Noon: For in the larger Triangles ⊙ P *g*, ⊙ P *o*, are known, ⊙ P the Suns distance from the Pole, P *o* = P *g*, the distance of the Pole from the Vertex, with the sides ⊙ *o*, ⊙ *g* Quadrants; to find P *o* ⊙ or P *g* ⊙ the Suns Azimuth, in this case from the North Rising or Setting; and ⊙ P *o* or ⊙ P *g*, the time before or after Noon: But in this case because the Angles ⊙ P *o*, ⊙ P *g*, are obtuse, it may be more convenient to use the lesser Triangles, in which are given P *i*, the Reflection, P *o* = P *g*, as before, and the Angles at *i* right, to find P *g i*, or P *o i* (the Complements of ⊙ *g i* and ⊙ *o i*) the Suns Amplitudes Rising or Setting from the East or West: and *i* P *o* = *i* P *g*, the time of his Rising after, or Setting before Midnight; I shall make use of the oriental of these lesser Triangles, in which it will hold, Fig. 4.

S, P *g*, R :: *s*, P *i*, *i* P *g*, or,

As the Co-sine of the Latitude,	51	30	00 9,794149
To the Radius;	S. 90	00	00 10,000000
So the Sine of the Reflection,	16	21	57 9,449894
To the Sine of the Amplitude.	26	54	45 9,655745

Whose Complement to a Quadrant 63° 05′ 15″ is the Suns Azimuth, in this case from the North, but when the Pole is in the obscure Hemisphere, from the South Meridian, in his Rising or Setting.

For the Ascensional Difference, say,

s, P *g*, R :: *s*, P *i*, *os*, P *g i*, or,

As the Co-Tangent of the Latitude,	51	30	00 9,900605
To the Tangent of the Reflection;	26	21	57 9,467856
So the Radius,	S. 90	00	00 10,000000
To the Sine of the Ascensional Difference	20	15	49 9,567251

Whose

68° 20′ 04″.
4h. 33′ 20″.
7h. 26′ 40″

Whose Complement 69° 44′ 11″ converted into time, gives the Suns Riſing 4h. 38′ 57″, and therefore that time of his Setting at 7h. 21′ 03″ Afternoon.

SECTION VIII.

THE *Meridional Diſtance of the Sun from the Vertex*, may be found only by comparing the Suns diſtance from the *Pole of the Globe*, with the diſtance of the *Vertex* from the ſame *Pole*: For the leſſer of theſe Subtracted from the greater, will leave the *Suns Meridional Diſtance from the Vertex*.

But Note, that if the *Suns Diſtance from the Pole*, be leſs than the diſtance of the *Path* from it; whence the Vertex paſſes the Meridian, he will appear betwixt the Pole and it; that is, to the North of the Vertex in Northern, and to the South in Southern Latitudes.

But if the Suns diſtance from the Pole be bigger than the Paths diſtance from it, he croſſes the Meridian to the South of the Vertex, in Northern Latitudes, and to the North in Southern.

And if the Sum of the Suns, and Paths diſtance from the Pole be leſs than 90 Degrees, he ſhall appear twice upon the Meridian in 24 hours, once above, and again after 12 hours beneath the Pole, the Difference of them being his diſtance from the Vertex to the South in Northern, to the North in Southern Latitudes; but their Sum, his remoteſt diſtance from the Vertex to the South, in Southern Latitudes; and to the North in Northern which frequently happens in thoſe places, that lie betwixt the Arctick and Antarctick Circles, and their Poles.

Hence the Rules are eaſily made for finding the Latitude, the Suns diſtance from either of the Poles, and his Meridional diſtance from the Vertex being given: but this I ſuppoſe has been already ſhewn. If the Reader finds it otherways, or think me deficient in this Point, it may excuſe me, when I have informed him, that I could not be permitted the ſight of what has been already Printed, upon which account it is I forbear leaſt I ſhould only do what has been already done, and therefore needleſs.

Fig. 3. In my third Figure, if according to theſe Rules, from the Suns diſtance from the Vertex ⊙P 73° 38′ 03″, you ſubtract the diſtance of the Path from the Pole 38° 30′ 00″, the reſidue 35° 08′ 03″, ſhall be ⊙*d*, the Suns Meridional diſtance from the Vertex at that time.

SECT.

SECTION IX.

THE Suns distance from the Pole, together with the hour from Noon being given, to find his distance from the Vertex in any given Latitude. *Fig.* 3.

Let the hour proposed be Four before Noon, or Eight in the Morning, and the Suns distance from the Pole as before.

Having made P T the Radius of a Tangent Line, and therewith divided the Line q T m both ways from T, the Points q and m will be found to fall 45 Degrees of the same, on each side T.

The Center of the proper Meridian is at m, Count therefore 60 Degrees (= to 4 hours) in the divided Tangent Line from m towards q, the Center of the Six a Clock Hour Circle, these shall terminate at y, and there is the Center of that Hour-Circle; which if setting one Foot of the Compasses on y, you strike through P, it shall form an Angle of 60 Degrees with the Meridian, and the Point 8, where it intersects the Path, shall be that place, the Vertex shall pass, at 8 a Clock in the Morning, or 4 hours before Noon.

Let the Arch of a Circle 8 ⊙, be struck through this Point and the Suns place, so as it may also pass through his opposite place *n*; then to find what is required, in the Oblique Angled Triangle P ⊙ 8, are given ⊙ P 8, the hour or Angle at the Pole 60° 00′ 00″, the distance of the Pole, and Path P 8, 38° 30′ 00″, with P ⊙ the distance of the Sun from the Pole 73° 38′ 03″, to find ⊙ 8 the required distance of the Vertex from the Sun: which will be gotten by the second Case of Oblique Spherical Triangles, for,

As the Radius,	*S.*	90	00 00	10,000000
To the Co-sine of the hour from Noon;		60	00 00	9,698970
So the Tangent of the Poles Distance from the Vertex,		38	30 00	9,900605
To the Tangent of first Segment.		21	41 19	9,599575

Which, because the Angle ⊙ P 8 is acute, the hour proposed being less than Six hours from Noon, subtracted from the Suns distance from the Pole 73° 38′ 03″, leaves the second Base or Segment 51° 56′ 44″.

Again,

As the Co-sine of the first Segment,		21	41 19	*Ar. Co.* 0,031888
To the Co-sine of the second;		51	56 44	9,789870
So the Sine of the Latitude,		51	30 00	9,893544
To the Co-sine of the ⊙ 1 Distance from the Vertex.		58	43 26	9,715302

Note, that when the hour proposed is more than Six from Noon, the Perpendicular falls without the Triangle, and then you must add the Suns distance from the Pole, to the first Segment, to get the second.

SECT.

SECTION X.

THE converse of the preceding propositions is of more frequent use in *Astronomy*, and therefore I shall next shew how, The Latitude of the place, the Suns distance from the Pole, with his observed distance from the Vertex, being given, to find the Hour from Noon.

Fig. 3. In the aforementioned Triangle ⊙P 8, let ⊙P represent the Suns distance from the Pole 73° 33' 03", P 8, the distance of the Pole from the Vertex, or Complement of the Latitude 38° 30' 00", and ⊙ 8 his distance from the Vertex before Noon, 58° 43' 26"; we have three sides of an Oblique Angled Spherical Triangle given, and the Angle at P required; which may be obtained by the 11 Case of such Oblique Angled Triangles. Wherefore add the three *data* together, and from half their Sum subtract the Suns distance from the Vertex, reserving the difference, then say,

As the Radius,
To the Sine of the Suns Distance from the Pole;
So is the Co-sine of the Latitude,
To a fourth Sine.

And Again,

As the fourth Sine,
To the Sine of half the Sum of the given sides;
So is the Sine of the Difference reserved,
To a seventh Sine.

To which if you add the Radius, half that Sum will be the Co-sine of half the hour from Noon. I proposed

The Suns Distance from the Pole P ⊙				73 38 03
The Complement of the Latitude P 8				38 30 00
The Suns Distance from the Vertex ⊙ 8				58 43 26
			Sum	170 51 29
			½ Sum	85 25 44½
			Subtract ⊙ 8	58 43 26
			Difference	26 42 18½
R = S,		90 00 00		10,000000
⊙P S,		73 38 03		9,982037
P 8 S,		38 30 00		9,794149
S,	4th. Arch			9,776186

Fourth

Fourth Arch *Ar. Co.*		0,223814
S, ½ Sum	85 25 44½	9,998616
S, Diff.	26 42 18½	9,652632
7 Sine ¼ R		19,875062
½ *cs*	30 00 00	9,937531

Doubled 60 00 00 = 4 hours, the time from Noon, or Eight in the Morning, at which the Suns diſtance from the Vertex, was found 58° 43′ 26″, in the work of the laſt procedeing Caſe.

SECTION XI.

THE Suns diſtance from the Pole, his diſtance from the Vertex, and the Latitude being given, if his Azimuth ſhall be required:

The caſe is the ſame with the preceding, for in the ſame Triangle ⊙ P 8, are given the three ſides P ⊙, P 8, 8 ⊙, as before, only whereas we then enquired the Angle at the Pole P, we muſt now ſeek the Angle at the Vertex 8, for that is the Suns Azimuth from the North part of the Meridian.

Add therefore as before the Suns diſtance from the Pole, his diſtance from the Vertex, and the Complement of the Latitude together, and from half that Sum ſubtract the Suns diſtance from the Pole, then ſay:

As the Radius,
To the ſine of the Suns Diſtance from the Vertex;
So the Co-ſine of the Latitude,
To a fourth ſine.

And Again,

As that fourth ſine,
To the ſine of the half Sum;
So the ſine of the Difference,
To a ſeventh ſine.

To which if you add the Radius, half that Sum will be the Co-ſine of half the Suns Azimuth from the North.

Let now the *data* be the ſame as in the laſt caſe, and the Suns Azimuth or the Angle at 8, enquired.

The Complement of the Latitude	P 8 is		38 30 00	
The Sunt Distance from the Vertex	⊙ 8		58 43 26	
From the Pole	P ⊙		73 38 03	
		Sum	170 51 29	
		½ Sum	85 25 44½	
The Suns distance from the Pole			73 38 03	
Subtracted leaves the Difference			11 47 41½	
Rad.	S,	90 00 00	10,000000	
8 ⊙,	S,	58 43 26	9,931801	
P 8,	S,	38 30 00	9,794149	
Fourth sine			9,725950	
Fourth sine		*Ar. Comp.*	0,274050	
½ Sum	S,	85 25 44½	9,998616	
Diff.	S,	11 47 41½	9,310498	
Z ± R			19,583164	
½ =	45	51 46 05	9,791582	

Doubled 103 32 10 the Suns Azimuth from the North Meridian, or the Angle at 8 required, its Complement to a Semicircle 76° 27′ 50″, his Azimuth from the South.

SECTION XII.

IF the end of the Twilight in the Evening, or the first dawn of the Day in the Morning, were required, it must be considered; that the Daylight reaches to the Horizon, when the Sun is 16 Degrees beneath it; or as the *Copernicans* had rather expres it, the Vertex sees the light of the Sun untill it be 16 Degrees distant from the Horizon of the Diske, in the obscure Hemisphere of the Earth. Count therefore 16 Degrees in the Periphery of the Ecliptick, from each of its intersections with the Horizon of the Diske, into the obscure Hemisphere, or from H to ϒ, and from r to e, then laying a Ruler over ϒ r, mark the Point n where it intersects the Line of the Suns Longitude.

Fig. 5e.

The Tangent of 74 Degrees (the Complement of 16) to the Radius e ϒ, shall be the Semidiameter of a Circle, that shall pass through these three Points; of which if you strike the Arch ϒ n ζ it shall be the *Parallel of* and *Twilight*, the Point ζ, wherein it intersects the occidental part of the Path, shall be that place the Vertex transits, when the Twilight ends in the Evening.

Strike

Strike the Arch of a Circle through this Point ζ, ſo as it may alſo paſs through the Sun, and his oppoſite place at ♈; through the ſaid Point and the Pole P, ſtrike alſo the Arch of an Hour-Circle ζP, ſo have you formed the oblique Angled Triangle Pζ⊙, in which are given Pζ the Complement of the Latitude 38° 30′, P⊙ the Suns diſtance from the Pole 73° 38′03″, and ⊙ζ, the Suns diſtance from the Parallel, to find the Angle at P, or the hour from Noon, when the Twilight ends, which may be obtained by the 11 caſe of Spherical oblique Angled Triangles, thus,

Add together the Suns diſtance from the Pole, his diſtance from the Parallel, and the Complement of the Latitude; from the half of the Sum ſubtract the Suns diſtanee from the Parallel, reſerving the difference. Then ſay,

As the Radius,
To the Co-ſine of the Latitude;
So is the ſine of the Suns Diſtance from the Pole,
To a fourth ſine.

And Again,

As that fourth ſine,
To the ſine of half the Sum of the ſides;
So is the ſine of the Difference, reſerved,
To a ſeventh ſine.

To which add the Radius; half the Sum ſhall be the Co-ſine of half the hour from Noon.

For Example.

When the Suns Diſtance from the Pole is		73	38 03
Complement of the Latitude		38	30 00
The Parallel from the Sun		106	00 00
	Sum	218	08 03
	½ Sum	109	04 01½
	⊙ζ Sub.	106	00 00
	Difference	3	04 01½
S,	90 00 00		10,000000
Pζ S,	38 30 00		9,794149
P⊙ S,	73 38 02		9,982037
S♈	4th. Arch		9,776186

		Ar. Comp.
Fourth Arch,		0,223814
☉ Sun ♑,	109 04 01½	9,975495
Difference ♑,	3 04 01½	8,728396
Z + Radius,		10,927705
☉ ♑,	73 05 02	9,463852
Doubled makes	146 10 04	equal to 9 h. 44′ 40″, at which

time the Twilight ends, and it becomes perfectly dark. Subtract these from 12 hours, the remainer 2 h. 15′ 20″, is the time of the first Day-break in the Morning, the Sun being in the same place in the Ecliptick; Note that where the Path cuts not the Parallel of Twilight, 'tis no perfect darkness at Midnight, but Twilight only lighter, or darker, as the Path approaches nearer the Parallel.

SECTION XIII.

IN the Calculation of Solar Eclipses, and the Moon's Transits over fixed Stars, it is usually required to know what Point of the Ecliptick Culminates in the Meridian, what is the highest Point of it, and the *nearest Distance* of each of these from the *Vertex*, and what is the Angle which the Vertical Circle makes with the Ecliptick, in any Point of it, at any given time. These are difficultly shewn in the *Ptolemaick* Projections, readily and easily in ours, thereby proving *that the most ingenious of human inventions, are far less facile then the ordinary performances of Truth and Nature*: I shall therefore next shew how each of these may be represented in the true System of the World, and calculated. Fig. 3.

Let the Suns place be as before proposed, and the forementioned requisites demanded to 2 h. Afternoon.

The Center of the proper Meridian is at *w*, Count 30 Degrees answering to 2 hours in the Tangent Line divided as before directed, from *w* to the right hand, an Hour-Circle struck with one Point of the Compasses set on the Point so found in the Tangent Line, through the Pole P, shall cut the Path in the Point θ, which the Vertex shall traverse at 2 hours after Noon, the Ecliptick upon the Point C on the Meridian, and a Line produced through the Pole, *e* and the intersection of the Path, and this Arch at θ, shall intersect the Ecliptick in the Nonagesime degree, or Point nearest the Vertex at N, C N being the distance of the Nonagesime degree from the Meridian, *e*N its distance from the Vertex, and C θ the distance of the Point on the Meridian from the Vertex.

θ

To define these by Calculation.

In the Triangle C ♋ P are given, ♋ P, the Complement of ♈ P ♋, the right Ascension of the Midheaven or Point of the Ecliptick in the Meridian 17° 28′ 25″, P ♋ as before 66° 31′, and the right Angle at ♋, to find ♋ C the Complement of ♈ C, the Longitude of the Midheaven from the first Point of the Ecliptick, and P C, the distance of the Midheaven from the Vertex, we may say, therefore, C

R. *t*, ♋PC :: *s*, P♋ . *t* ♋C, that is, G

As the Radius,	S.	90	00 00	10,000000
To the Co-tangent of the right Ascension of the Midheaven;		72	31 35	9,498024
So the sine of the Distance of the Pole and Tropick,		66	31 00	9,962453
To the Co-tangent of the Longitude of the Midheaven from the next Equinoctial Point.		73	53 45	9,460477

Therefore the Midheaven is ♎ 13° 53′ 45″; for P C it will hold,

R. *t*, ♋PC :: *t*, ♋P . *t* CP, or,

As the Radius,	S.	90	00 00	10,000000
To the Tangent of the Distance of the two Poles;		23	29 00	9,637956
So the sine of the right Ascension of the Midheaven,		72	31 35	9,979483
To the Co-tangent of its Distance from the next Pole.		67	29 24	9,617439

From which if according to the directions of the Eighth Section, we take away P ♑ 38° 30′, the distance of the Pole from the Vertex, the remainer ♑ C shall be the distance of the Midheaven from the Vertex, 28° 59′ 24″.

To find N ♋, the Complement of ♈ N, the Longitude of the Nonagesime, with N ♑ its distance from the Vertex; in the Oblique Angled Triangle, P *e* ♑, are given P *e* the distance of the two Poles 23° 29′, P ♑ the Complement of the Latitude, or Semidiameter of the Path 38° 30′, with the included Angle *e* P ♑, the difference of the right Ascensions of the Midheaven, and first Point of ♈ 162° 31′ 35″, to find the Angle P *e* ♑ = ♋ N, the Longitude of the Nonagesime from the first Point of ♋, with ♑ N, its distance from the Vertex, which may be obtained by the Second and Tenth Cases of Oblique Angled Spherical Triangles, for,

As the Radius,	90 00 00	10,000000
To the Co-tangent of the Latitude;	51 30 00	9,900605
So the ſine of the right Aſcenſion of the Midheaven counted from ♈ *or* ♎,	72 31 35	9,979483
To the Tangent of the firſt Segment.	37 11 20	9,880088

If the Angle ℓ P ϑ be obtuſe, as in this Caſe, the Sum of the firſt Segment and the diſtance of the two Poles; but if it be acute, their difference, ſhall be the ſecond Segment.

In this Caſe therefore the ſecond Segment will be 60° 40′ 20″.

Say Again,

As the ſine of the ſecond Segment,	60 40 20 *Ar. C.*	0,059567
To the ſine of the firſt;	37 11 20	9,781356
So the Co-ſine of the right Aſcenſion of the Midheaven from ♈ *or* ♎,	62 31 35	9,498024
To the Co-ſine of its Longitude.	77 41 18	9,338947

Therefore the Nonageſime ♊ 17° 41′ 18″, for its diſtance from the Vertex, ſay,

As the Co-ſine of the firſt Segment,	37 11 20 *Ar. C.*	0,098734
To the Co-ſine of the ſecond Segment;	60 40 20	9,893544
So the Co-ſine of the Latitude,	51 30 00	9,690023
To the ſine of its Vertical Diſtance.	28 45 43 ϑ N	9,682301

Whoſe Complement 61° 14′ 17″, *is its Diſtance from the Horizon.*

If it be demanded, what Angle the Circle paſſing from the Vertex to the Sun, makes with the Ecliptick at his Center, ſtrike a Circle through the Sun, his oppoſite place ♑, and the Vertex; So ſhall you form the Triangle ϑ N ☉, in which are given N ☉, the Suns diſtance from the Nonageſime 32° 41′ 18″, N ϑ the diſtance of the Nonageſime from the Vertex, and the Angle at N right, to find the Parallactick, or required Angle, you may ſay therefore,

S, N ☉ . R :: t, N ϑ . t N ☉ ϑ, or,

As the ſine of the ☉*'s Diſtance from the Nonageſime,*	32 41 18	9,732449
To the Radius;	90 00 00	10,000000
So the Tangent of the Diſtance from the Vertex,	28 45 43	9,739485
To the Tangent of the Parallactick Angle.	45 27 31	10,007036

But

But if the Parallactick Angle at the Moon, or some Star that has Latitude from the Ecliptick, be demanded; it will require some farther labour to investigate it. Let the time proposed, and consequently the Nonagesime Degree, and the distance of the Vertex from the Pole be as before found, and let the Parallactick Angle at *Pollux*, whose Longitude is ♋ 18° 47′ 30″, distance from the Pole of the Ecliptick 83° 21′ 30″, be demanded: Let ✳ represent the place of *Pollux*, the Arch N V equal to the Angle θ e ✳, the difference of the Longitude of *Pollux* and the Nonagesime, shall be 31° 06′ 12″: Strike the Arch of a great Circle ✳ θ from the Vertex to *Pollux*, so have you formed the Oblique Angled Spherical Triangle, ✳ P θ, in which are known e θ, the distance of the Vertex from the Pole of the Ecliptick 61° 14′ 17″, with e ✳ the distance of *Pollux* from the Pole of the Ecliptick 83° 21′ 30″, and the Angle θ e ✳ as before, to find the Angle e ✳ θ, the Complement of the Parallactick Angle, with θ ✳ the distance of the Star from the Vertex, which will be got by the second and tenth Cases of Oblique Angled Spherical Triangles, by which it will hold:

As the Radius,	90 00 00	10,000000
To the Co-sine of the ✳ Distance from the Nonagesime;	31 06 12	9,932594
So the Tangent of the Distance of the Vertex from the Pole of the Ecliptick,	61 14 17	10,260515
To the Tangent of the first Segment.	57 20 17	10,193109

The difference betwixt the first Segment, and the Stars distance from the Pole of the Ecliptick, shall be the second Segment in this Case 26° 01′ 13″.

Say Again,

As the sine of the second Segment,	26 01 13 *Ar.C.*	0,357843
To the sine of the first,	57 20 17	9,925245
So is the Tangent of the ✳ Distance from the Nonagesime Degree,	31 06 12	9,780546
To the Co-tangent of the Parallactick Angle.	40 49 02	10,063634

And for the Stars distance from the Vertex,

As the Co-sine of the first Segment,	57 20 17 *Ar.C.*	0,267865
To the Co-sine of the second Segment,	26 01 13	9,953585
So the Co-sine of the Distance of the Vertex from the Pole of the Ecliptick,	61 14 17	9,682316
To the Co-sine of the ✳ Distance from the Vertex.	36 45 04	9,903764

SECT. II.

SECTION XIV.

HOwever large the Diameter of the Earths Annual Orb may appear to be, collated with her own Diameter, yet if it be compared with the vast distance at which the fixed Stars are placed, the Angle it subtends becomes almost insensible. So that in what part soever of her Orbit the Earth is found, she is yet conceived by *Copernicans* as in the Center of the Starry Sphere; and then lines produced from her Center to each Star shall design their places in that Rete, which we before imagined to invest its superficies; and their Longitudes and right Ascensions, will be determined by their respect to the Equinoctial Point, and Colure; their Latitudes by their distances from the Ecliptick; and their Declinations, by the like distances from the Circle bisecting the Globe, equally distant from both its Poles, called the *Equator*.

The distances and positions of the fixed Stars one from another, have been found the same in all Ages; so that it is probable they are subject to no Motion; but what appears in them by reason of the continual recess of the Earths Equinoctial Points; the manner and reason whereof, will be conceived by the first Figure; In which view the Earth at ♎, its Motion round its Axis is from West to East, or from *d* by *i* to *t* in the illuminate part of the Globe, or that next the Sun. But the Motion of the Ætherial Matter is also from West to East, or from ♈ to ♓ directly contrary to this in the same illuminate part of the Globe, and that too something stronger than in the remoter or obscure part; by reason the parts near the Sun are swiftlier moved than the more remote; thence it proceeds that the *Line of Direction*, or Plane connecting the Poles *t P e d*, is reflected and born back contrary to the Earths, and *Vortex* Motion, 50 Seconds Annually. So that whereas about the beginning of *Nabonassar's Æra*, it cut the Ecliptick, and consequently made the Solstice, near the Cloudy place in ♋, it is now carried back to the Heel of of *Castor*, and about 250 years hence, it will make the Solstice when the Earth passes under *Procyon*.

Fig. 1.

That Point of the Orbit, where when the Earth arrives, the Line of direction, or Solstitial Colure, coincedes with the Horizon of the Diske, and the North Pole, passing out of the obscure, begins to enter the illuminate part of the Globe, is the place where the vernal Equinox is made, and the Sun enters the first Point of ♈. This Point about the time of *Nabonassar*, was at N, but since by the continual impression of the Ætherial matter, and its renitency to the Earths Motion, 'tis reflected equally with the Solstitial Colure, which is altered from *n e a* to *t e d* receding continually, so that if the Earth continue some Ages longer, the Equinoctials may happen under those Stars, near which the Solstices were celebrated at the Creation.

Hence

Hence it is that the places of the Equinoxes receding from the fixed Stars, they seem to move slowly, but equally forward from the Equinoxes, about one Degree in 72 years, those which appeared near the Equinoctial Points, or some few Degrees in Antecedence, as *Spica* ♍ did in the time of *Hipparchus*, being now found near 20 Degrees in consequence of them.

But though the Longitudes of the Stars alter yearly, yet may their places once determined to a known year, be made out to any other, past or to come, by the sole Subtraction or Addition of so many times 50 Seconds from or to the given Longitude, as there are years betwixt that to which the place of the Star given is rectified, and at which it is demanded. Their Latitudes vary not, but their right Ascensions and Declinations depending on these, are continually changing, and that not regularly, but unequally, more or less according to the distances of each Star from the Pole of the Ecliptick, and the Colures. It will be therefore requisit to shew how from the given Longitude and Latitude of a Star, its right Ascension and Declination may be Calculated.

Let the Star proposed be *Pollux*, whose place to this year 1680. is stated ♋ 18° 47′ ½, and let its place, right Ascension, and Declination, be required to the year 1800. or 120 years hence.

To its given place 1680,	♋	18	47 30
Add the Motion for 120 *years future*;		1	40 00
It makes the Star's place to the year 1800, *in*	♋	20	27 30
Its constant Distance from the Pole of the Ecliptick being.		83	21 30

Let ✳ represent the place of *Pollux* on the Globe, *e* ✳ his distance from the Pole of the Ecliptick 83° 21′ 30″; and P *e* ✳ his Longitude from the Solstitial Colures 20° 27′ 30″, P *e*, the distance of the two Poles 23° 29′; we have here two sides of an Oblique Angled Spherical Triangle given, with the Angle betwixt them, to find the third side, and the Angle at P, which will be got by the Second and Tenth Cases of such Triangles, by these proportions.

As the Radius,	S.	90	00 00	10,000000
To the Tangent of the Stars Distance from the Pole of the Ecliptick,		83	21 30	10,933894
So the Co-sine of its Longitude from the Solstitial Colure,		20	27 30	9,971705
To the Tangent of the first Segment.		82	54 56	10,905599

When the Stars place is in the first six Signs of the Ecliptick, as in this Case, the difference betwixt the first Segment, and the distance betwixt the two Poles, shall be the second Segment; otherways their Sum shall make it.

The second Segment therefore in Pollux, 59° 25' 56".

Say Again,

As the sine of the second Segment,	59 25 56	*Ar. Co.* 0,064983
To the sine of the first Segment;	82 54 56	9,996672
So the Tangent of the Stars Latitude from the next Solstitial Colure,	20 27 50	9,571774
To the Tangent of its right Ascension from the same Colure.	23 15 57	9,633429

The right Ascension of the Colure is 90°, therefore of *Pollux* to the year 1800. will be 113° 15' 57". For its distance from the Pole of the Globe, say,

As the Co-sine of the first Segment,	82 54 56	*Ar. Co.* 9,008924
To the Co-sine of the second Segment;	59 25 56	9,706339
So the Co-sine of the Stars Distance from the Pole of the Ecliptick,	83 21 30	9,063181
To the sine of its Declination.	28 29 04	9,678444

Whose Complement 61° 30' 56", *is its Distance from the North Pole of the Globe.*

If the Angle P ✱ ♑, or the visible inclination of the Axis of the Globe to the Axis of the Ecliptick be demanded, it will hold,

As the sine of the Stars Distance from the Pole of the Ecliptick,	83 21 30	*Ar. Co.* 0,002925
To the sine of its right Ascension from the Colure;	23 15 57	9,596595
So the sine of the Distance of the Poles,	23 29 00	9,600408
To the sine of the Inclination.	09 07 04	9,199929

I might here proceed to shew how several other requisites in the *Sphere* would be formed and represented in this Projection, but it will be convenient to leave something imperfect, to exercise the Ingenuity of the Student; who if he throughly understand the preceding discourse, will readily find places wherein any other Problem will be determined. I shall therefore close this part, and in the following I shall shew how by a like, but Orthographical Projection of the Globe, the Moons Appulses to the Sun or Stars may be constructed, and all the Appearances of an Eclipse, Occultation or Transit represented to the Eye for several Latitudes in one Figure; which will be of great use to the Ingenious *Astronomer, Traveller,* and *Seaman,* and was never to be expected from any Hypothesis, that did not admit the Motion of the Earth.

THE DOCTRINE OF THE SPHERE.

BEING

An improvement of the Learned KEPLER's *Method of Calculating the Longitude and Latitude of those places where the Principal Phases of a Solar Eclipse shall be seen.*

And shewing further, how the time when any given Digits, if possible, shall be observed in the Solar Eclipse. The inclination of the Cusps; the time of the Moons nearest approach to Fixed Stars, their occultations and emersions from her; &c. in the Visible, or any given Longitude and Latitude; without the Calculation of the Parallaxis, by Rules and Canons.

By the help of a New Projection of the Globe, grounded on the Pythagorean or Copernican Hypothesis.

PART II.

SECTION I.

IMagin a Plane to touch the Moons Orbit at any Point, and to stand at right angles to the Line Connecting the Centers of the Earth and Sun, or any Star interfects it, and to stand at right Angles with the said Line.

If infinite streight Lines be conceived to pass from the Center of the Sun, or any Star through this Plane to the Periphery of the Earth, its Axis, the Axis of the Ecliptick, and the Path of any Vertex; they shall project the Earths Diske, the Axis of the Globe, and the Ecliptick, with the Path of the Vertex on the said Plane, and this is the Projection we are to delineate.

1. View the first Figure, it will thence be evident that when the Sun or any Star is in ♋ ♌ ♍ ♎ ♏, the Northern half of the Axis of the Globe, projected on the same Plane, viewed on that side next the Earth, lies to the right hand from the Axis of the Ecliptick; but if the Longitude of the Sun or Star be in any of the six opposite Signs, to the left hand from it.

2. That when the Suns apparent place happens to be either in ♈ ♉ ♊ ♋ ♌ or ♍; or the Line Connecting any Stars with the Earths Center, passes through its superficies in some place less than 90 Degrees distant from its Northern Pole; the said Pole lies in the *illuminate* or visible part of the Disk, otherways in the *Obscure*.

3. That when the Suns place in the Ecliptick, or any Stars on the Globe, is 90 Degrees distant from either Pole, *the Paths of the Vertexes*, or all Circles on the Globe parallel to the Equator will be projected in streight Lines, but in all other places as Ellipses, whose Conjugate Diameters will be so much the less, as the said places of the Sun or Stars fall nearer the Equator.

4. That the *Transverse Diameter* of the Ellipsis representing any *Path*, shall be equal to the doubled right sine of the distance of the said Vertex from the Pole; but the *Conjugate*, to the difference of the right sines of the Sum, and difference of the distances of the Path and Sun, or Star from the same Pole.

5. That the *Transverse Diameter* of every Path lies at right Angles to the Axis of the Globe; the *Conjugate* coinceding with it.

These things being duly considered, let it be required to represent in *Plano* the Path of a Vertex in the Earths Disk, whose distance from the North Pole is 38° 32', the Suns place being in ♋ 20° 51' ⅔, Semblable to that which will be projected on a Plane, touching her Orbit in that Point by streight Lines produced from the Sun to the Earth.

Fig. 8. Having struck the Semi-Circle H *s r* in the Eighth Figure; let it represent the Northern half of the Earths illuminate Disk projected on the said Plane, ⊙ its Center, the point therein opposite to the Sun. H ⊙ *r* an Arch of the Ecliptick passing through it. Upon ⊙ raise ⊙ *s* perpendicular to the Ecliptick H *r*, the Point *r* where it intersects the Limb of the Disk, shall be the Pole of the Ecliptick, ⊙ *r* its Axis.

Make ⊙ *e* equal to the Radius of a *Line of Chords*, from which taking the *Chord* of 23° 29', (the constant distance of the two Poles) set it off from *e* on both sides to *b* and *c*, draw the Line *b c*; in this the Northern Pole of the World shall be found.

Make *b a* equal to *a c* the half of this Line the Radius of a *Line of sines*, and therein set off the *sine* of the Suns distance from the *Solstitial Colure* 20° 51' ⅔, in this case (because the Sun is in ♋) from *a* to P, on the right hand the Axis of the Ecliptick, draw the Line ⊙ P, it shall be the *Axis of the Globe*, and P the place of the *Northern Pole* in the illuminate Hemisphere of the Disk.

Or the Angle *s* ⊙ *s*, which the *Axes* form with each other, may be more accurately determined by Calculation: For,

As

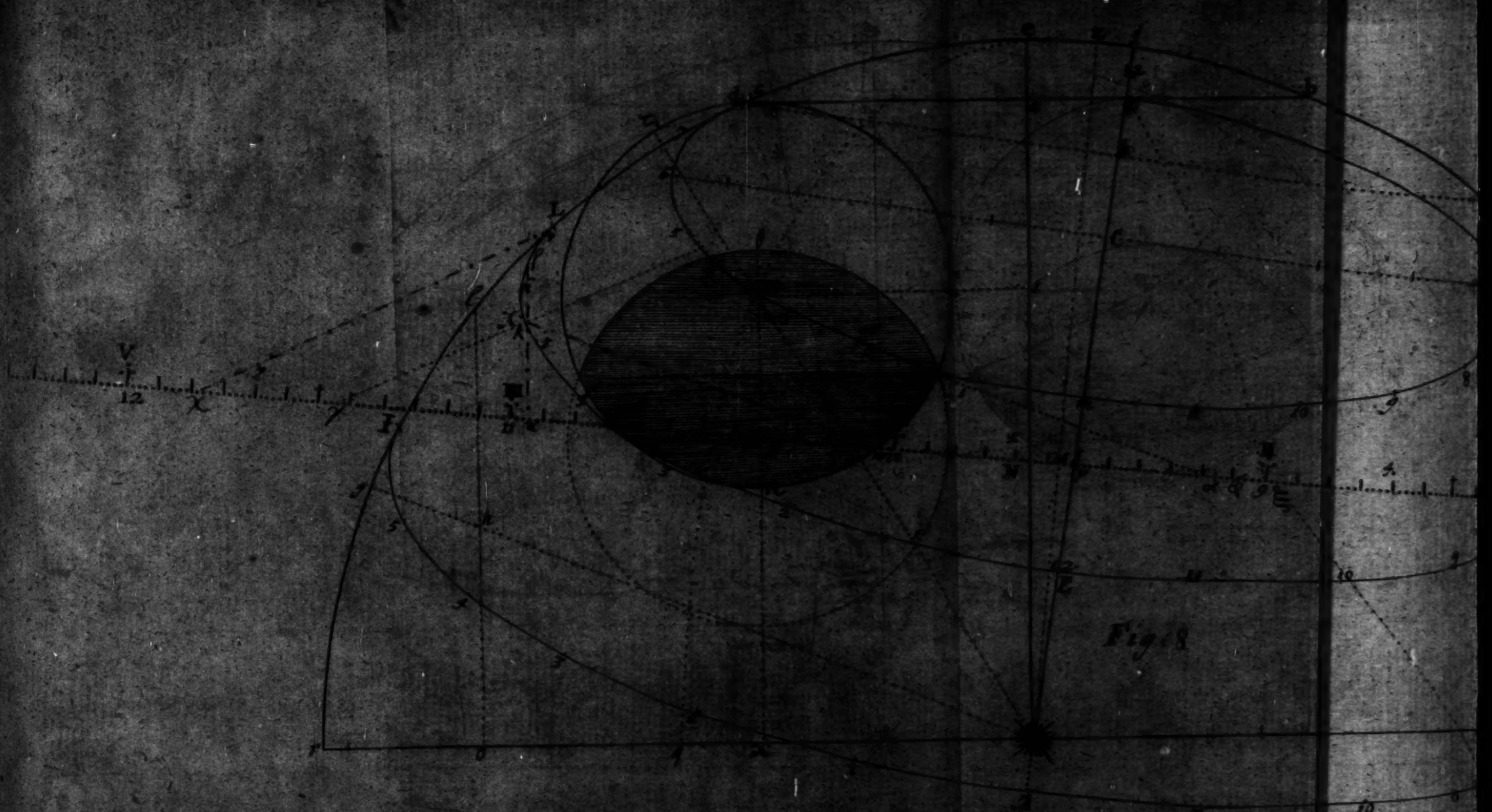


Fig. 8

A Scale of Minutes

Fig. 10

between page 28 and 29 the Doctrine of the Sphere

For the Solar Eclipse
July the 2. 1684.

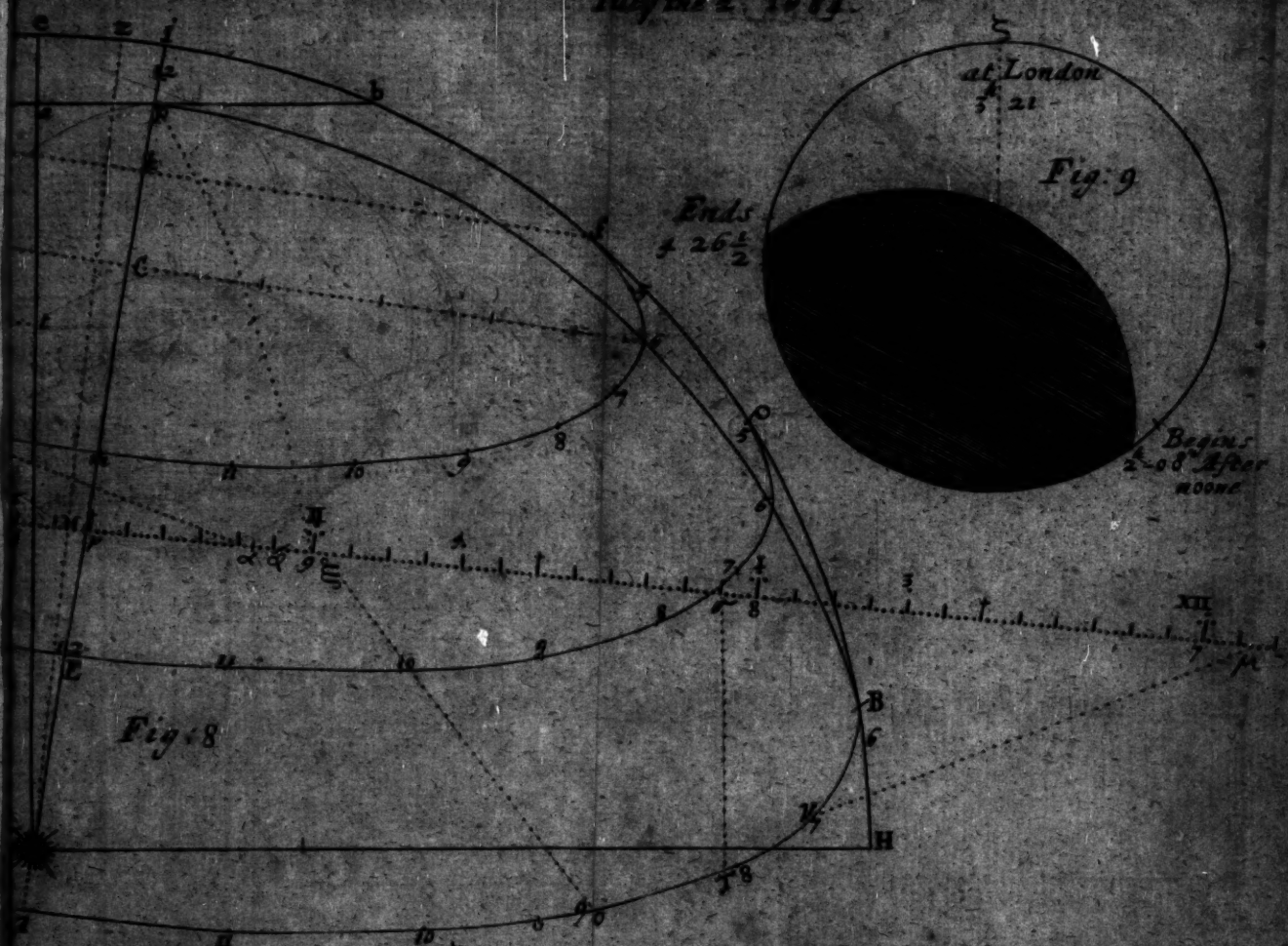


Fig: 8

Fig: 9

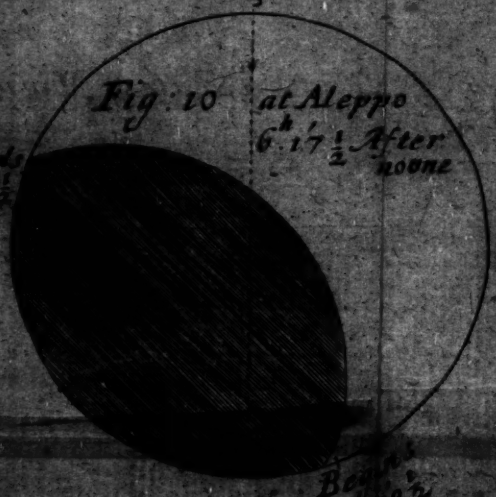


Fig: 10

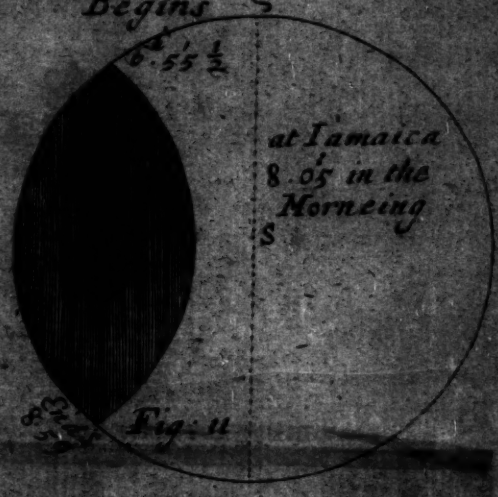


Fig: 11

As the Radius,	*S.*	90	00	00	10,000000
To the ſine of the Suns Longitude from the Solſtitial Colure;		20	51	40	9,551557
So the Tangent of the greateſt Reflection,		23	29	00	9,637956
To the Tangent of the Inclination of the Axis.		8	47	40	9,189533

Count the ſaid 8° 47′ $\frac{1}{3}$ in the Limb of the Diſk from *e* to *i* on the right hand, and draw the Line ⊙*i*, this ſhall be the Axis; and the Point P, where it interſects the Line *b c*, the place of the *Pole* in the illuminate Diſk.

The next thing required will be the Suns diſtance from the Pole, which by the precepts of the fourth Section of the foregoing part will be found 68° 8′ $\frac{1}{3}$; this added to the diſtance of the Vertex from the Pole 38° 32′, makes 106° 40′ $\frac{1}{3}$, the diſtance of the Vertex from the Sun at Midnight; but ſubtracted from it leaves 29° 36′ $\frac{1}{3}$, the Meridional diſtance of the Sun from the Vertex.

Make ⊙*e* the Radius of the Diſk, to be the *Radius* of a Line of ſines, from which take the ſine of 73° 19′ $\frac{2}{3}$, (the Complement of 106° 40′ $\frac{1}{3}$ to a Semi-Circle) and ſet it off in the Axis from ⊙ to 12, it there gives the *Meridional Interſection of the Nocturnal Arch of the Path with the Axis.*

Take the ſine of 29° 36′ $\frac{1}{3}$, from the ſame Line of ſines, and ſet it off in like manner the ſame way to *m*, it ſhews there the *Interſection of the Diurnal Arch of the Path with the Meridian.*

Biſect 12 *m* in C, and there through draw 6 C 6 at right Angles to the Axis of the Globe, and then taking the ſine of 38° 32′ the diſtance of the Pole from the Vertex; ſet it off from C on both ſides upon the ſaid Line to 6, 66 ſhall be the *Tranſverſe Diameter*, C 6 *the like Semidiameter of the Path.*

Making C 6 equal the Radius of a Line of ſines, if from the ſame you take the right ſines of 15, 30, 45, 60, 75 Degrees; and ſet them off ſeverally from C both ways in the tranſverſe Diameter, and from the Points ſo found, erect Perpendiculars on both ſides it, equal to the Co-ſines of the ſaid Arches, taken from a Line of ſines, whoſe Radius ſhall be C 12 equal to C *m*, you will have 24 Points given, through which the Ellipſis repreſenting the Path ſhall paſs, which ſhall alſo ſhew the place of the Vertex to every hour of the day.

Let it be Noted, that when the elevated Pole is in the obſcure Hemiſphere of the Globe, the Diurnal Arch or illuminate part of the Path, is in that part of the Ellipſis which lies neareſt the ſaid Pole, otherways in the more remote; and where the Ellipſis cuts the Limb of the Diſk, are the Points on it, from which the Sun appears to riſe and ſet; theſe may thus be found.

Count

Declination

H

Count the collection in the Limb of the Disk from ♈ to *g*, and the Complement of the Latitude from the same Point to *l*, from the Center ⊙ to *g*, draw ⊙*g*; and from *l*, let fall *l o*, Perpendicular to ⊙*g*; take ⊙*b* or the distance of the Point, wherein these two Lines intersect each other from the Center ⊙, and setting one Foot of your Compasses at ⊙, transfer that distance in the Axis from ⊙ to *k*, through *k* draw a Line parallel to the transverse Diameter of the Path, it shall intersect the Horizon, or Limb of the Disk in *f* and *d*, where the Path shall also cut it, or the Arch *i d* = *i f* may be more accurately defin'd by Calculation; for in the Triangle *i* P⊙ are given *i* P, the Complement of the Suns distance from the Pole, P*d* the distance of the Path from it, and the right Angle at *i*, to find the Arch *i d*; it will hold therefore:

Fig. 8.

c*i* P*i* . R :: c*s*, P*d* . c*s*, *id*, that is,

As the sine of the Suns distance from the Pole,		68	08	20	9,967590
To the Radius;	*S.*	90	00	00	10,000000
So the sine of the Latitude,		51	28	00	9,893343
To the Co-sine of the Arch i d = i f.		32	33	25	9,925753

Which if we shall have occasion to mention hereafter, I think we may not improperly call *the Amplitude of the Path in the Horizon of the Disk*.

In this Projection of the Globe we have given at all times of the day,

1. The Suns distance from the Vertex.
2. The Angle of the Vertical Circle, passing through the Suns Center with the Ecliptick.
3. The distance of the Nonagesime degree from the Vertex.

For if ⊙H the Radius of the Earths Disk, be made equal to the sine of 90 Degrees, a Line drawn from ⊙ to any hour of the Path, shall shew the *Angle which the Vertical Circle passing by the Suns Center formes with the Ecliptick*, and the distance of the hour Point from ⊙, shall be the right *sine of the Suns distance from the Vertex at that hour*.

And if from the said Point, a Line be let fall Perpendicular to the Ecliptick H*r*, that line shall be the *right sine of the distance of the Nonagesime degree from the Vertex*.

If farther, a Quadrant of an Ellipsis be drawn from the Pole of the Ecliptick *e*, through the said Point in the Path, to the Ecliptick H*r*, the distance of the place where the said Ellipsis shall intersect the Ecliptick, from the Center ⊙ shall be *the sine of the Suns distance from the Nonagesime Degree*.

The *Parallaxes of Altitude, Longitude and Latitude*, are in proportion to each other as the sines of the several distances of any appearances from the *Vertex*, *the Nonagesime degree*, and the *sine of the distance of the Nonagesime from the Vertex*.

If

If therefore we ſuppoſe the Moon without Latitude to have the ſame viſible Longitude with the Sun, and make the Radius of the Disk a Scale of equal parts, equal to her Horizontal Parallax, then will the diſtance of the Vertex from the Center, meaſured on the ſaid Scale, be the *Parallax of Altitude*, the neareſt diſtance of the ſaid Point to the Axis of the Ecliptick $o\odot$, *the Parallax of Longitude*; and the diſtance of the ſaid Point, from the next Point of the Ecliptick *the Parallax of Latitude*, that is in the Eighth Figure at $3\frac{1}{2}$ hours Afternoon: If $\odot o$ be made the Radius of a Line of Sines, $\odot s$ will be the ſine of the Moons diſtance from the Vertex, $\odot q$ her diſtance from the Nonageſime, and $s\chi$ the ſine of the diſtance of the Vertex from the Nonageſime; and therefore if $\odot s$ be made equal to the Moons Horizontal Parallax when ſhe obteins the ſame viſible place with the Sun,

$\odot s$ *will be her Parallax in Altitude*;
$s\varphi$ *in Longitude*;
$s\chi$ *in Latitude*.

So it appears, the Parallaxes in Altitude, Longitude and Latitude, are only the viſible removes of the Vertex of any place from the Center of the Earths Disk, the Axis of the Ecliptick, and the Ecliptick it ſelf, or a Parallel to it, paſſing through the Center of the Earths Disk.

SECTION II.

THE Semilatitude of this Projection by the Learned *Kepler*, is called (but ſomething improperly) *the Semidiameter of the Earths Disk*, and thoſe who from him have taught the Method of Calculating the general *Phaſes* of Solar Eclipſes, have all made uſe of the ſame Appellation: It is diſingenuous to contend about the Propriety of words, when we are agreed of their uſe and Signification; I ſhall therefore call it ſtill by the ſame name, and paſſing by the Errors of that deſerving Perſon in limiting its breadth, I ſhall ſhew that it is equal always to the difference of the Horizontal Parallaxes of the Luminaries.

Let $\odot$ repreſent the Suns, T the Earths Center; $\odot e$ his, T$\varnothing$ her Semidiameter; P $f a d s$ an Arch of the Moons Orbit lying betwixt the Sun and Earth, or rather the Limb of that Plane which I ſuppoſed to touch it, ſtanding at right Angles to the Line T$\odot$, connecting their Centers; draw ob a Tangent Line to the Earths Superficies Parallel to $\odot$T, and from the Point of Contingence $o\odot$, as alſo os; then is the Angle aos, or as the Moons Horizontal Parallax, $aad = bo\odot$, or ad the Suns, and dos, or sd their difference, the Semidiameter of the Earths Disk projected in this place. Fig. 6.

From

From *o* let *o e* be drawn to the Extremity of the Suns Semidiameter, then ſhall the Line *f d* repreſent the Suns Semidiameter projected on that place of the Plane: from *f* farther extend *f p* the Moons Semidiameter, the Sum of theſe *p d*, is that which we call the *Semidiameter of the Penumbra*.

But in the Appulſes of the Moon to Fixed Stars, the Horizontal Parallax it ſelf ſhall be the Semidiameter of the Disk, and her Semidiameter, the Semdiameter of the Penumbra, for that the Horizontal Parallaxes of the Fixed Stars are wholly inſenſible, and their Semidiameters ſo ſmall that we need not make any allowance for them.

Conceive the Line of the Moons paſſage betwixt the Sun and Earth, to interſect the Line connecting their Centers, or to paſs through the Center of the Disk projected on the forementioned Plane, and let the Station of the Obſerver be at *o*, when the diſtance of the Moons Center from the Center of the Disk, ſhall be equal to the Semidiameter of the Disk, Sun, and Moon added together; the Penumbra firſt begins to enter the Earths Disk, and the Moons following Limb Eclipſes the Suns Antecedent to the Obſerver at *o*, in his Vertical Point as he riſes; for the Moons Limb *f*, then firſt touches the Line produced from the Obſerver to the extremity of the Suns Diameter.

When the ſaid Limb of the Moon *f*, ſhall touch the point *d*, where the Line produced from the Inhabitant at *o* to the Suns Center interſects the Plane, the Sun will appear 6 Digits Eclipſed, and when the Moons Center P, comes to the ſame Point *d*, the Sun will be Centrally Eclipſed to the Inhabitant at *o* in his riſing.

Further, when the Moons Center arrives at *s*, the Sun will be Centrally Eclipſed to the Inhabitant at *y*, in the Nonageſime Degree; at *z*, to the Inhabitant at *x* in his ſetting; and when the upper Limb *q* touches the Line *x g*, the Eclipſe will end to the Inhabitant at *x*, in the upper Limb of the ſetting Sun.

How the Points on the Earth where theſe appearances happen may be found, we ſhall take occaſion to ſhew, after we have taught how to find the Times of the true Conjunctions or Oppoſitions of the Luminaries, at preſent let it be farther conſidered.

That the Moons Orbit being inclin'd to the Plane of the Ecliptick, if the Nodes, or Points wherein they interſect each other, happen upon the Center of the Disk, the Moons way in her paſſage over it will appear to be a perfect ſtreight Line, but otherways an Arch of an Ellipſis, whoſe tranſverſe Semidiameter ſhall be the Radius of her Orbit; but the Conjugate, the doubled right ſine of her diſtance from the Center of the Disk in her neareſt approach to it, which by reaſon of the ſmall breadth of the Disk, and the narrowneſs of the Ellipſis, may without any material Error be conſidered and employed, as if it were a perfect ſtreight Line.

If therefore the diſtance of the Moons Center, from the Center of the Disk at the time of her Conjunction with the Sun, be greater than the Semidiameters of the Disk, Sun, and Moon added together, ſhe Eclipſes no part of the Earth; but if leſs, ſhe will cover the Sun or Star, whetherſoever

And

ſhe

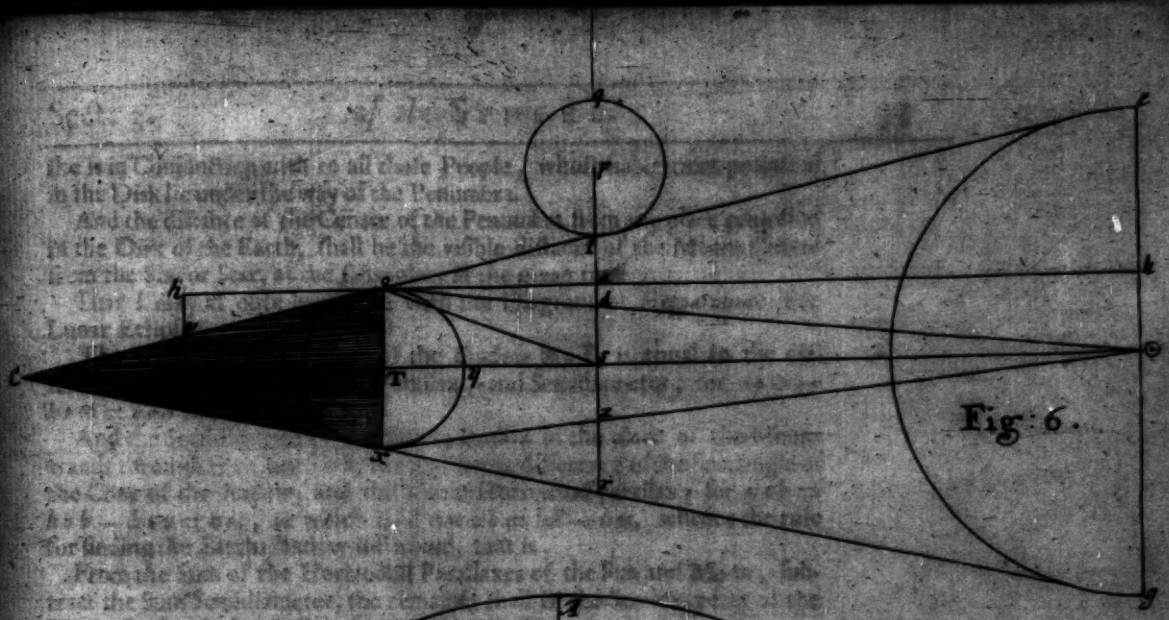


Fig: 6.

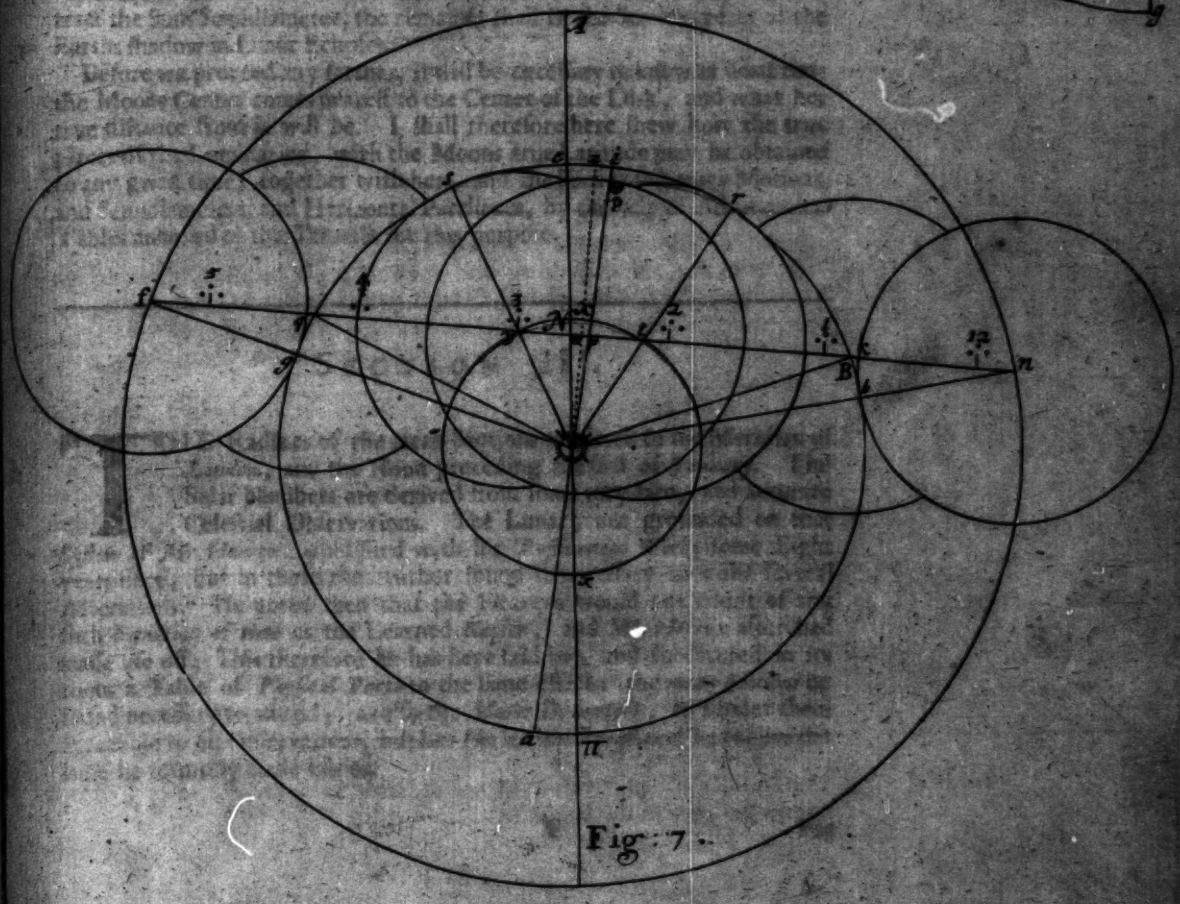


Fig: 7.

tweene page 32 and 33 the Doctrine of the Sphere.

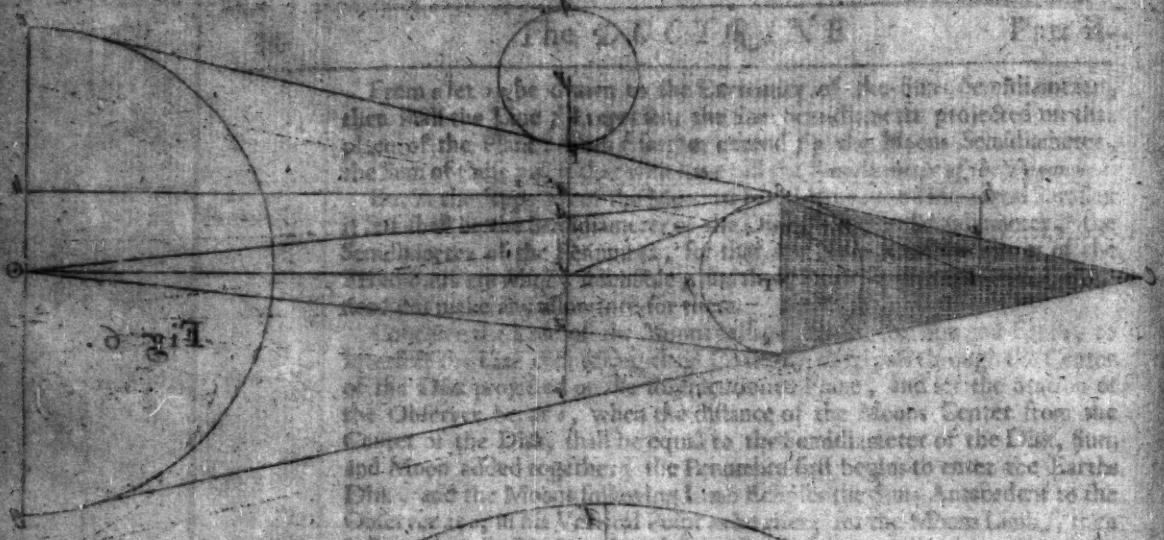


Fig 6.

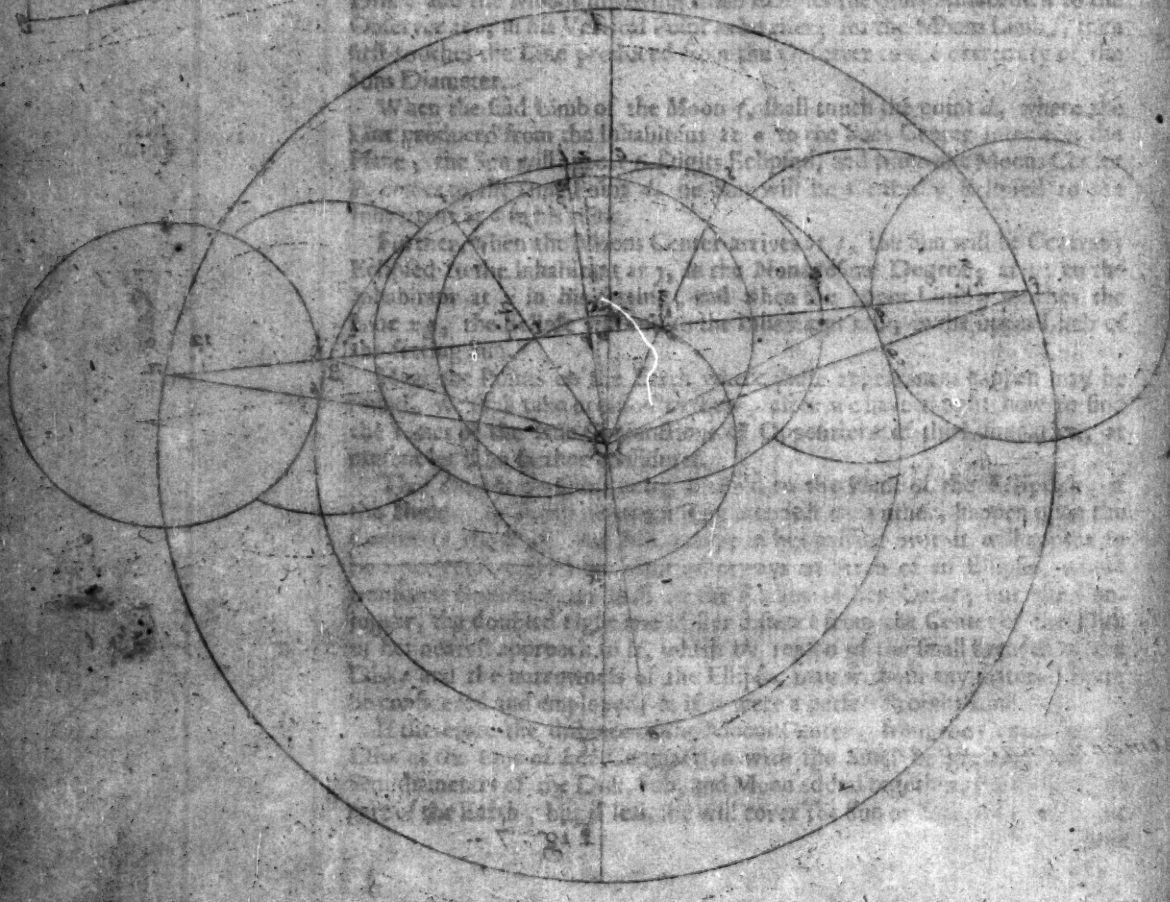


Fig 7.

ſhe is in Conjunction with to all thoſe People, whoſe habitations projected in the Disk lie under the way of the Penumbra.

And the diſtance of the Center of the Penumbra from any place projected in the Disk of the Earth, ſhall be the viſible diſtance of the Moons Center from the Sun or Star, at the ſame place at the given time.

That I may at once have done with the Diagram of *Hypparchus*: For Lunar Eclipſes.

The Semiangle of the Cone of the ſhadow ☽ *c* T, is equal to the difference of the Suns Horizontal Parallax, and Semidiameter, for *co* ☉ — *ho* ☉ = *coh* = *oc* T.

And the Semidiameter of the Earths ſhadow in the place of the Moons tranſit through the Cone *voh*, is equal to the difference of the Semiangle of the Cone of the ſhadow, and the Moons Horizontal parallax, for *voh* = *hob* — *hov* = *boc*, or which is all one *vb* = *hb* — *hv*, whence the rule for finding the Earths ſhadow is derived, that is,

From the Sum of the Horizontal Parallaxes of the Sun and Moon, ſubtract the Suns Semidiameter, the remainer ſhall be the Semidiameter of the Earths ſhadow in Lunar Eclipſes.

Before we proceed any further, it will be neceſſary to know at what time the Moons Center comes neareſt to the Center of the Disk, and what her true diſtance from it will be. I ſhall therefore here ſhew how the true places of the Luminaries, with the Moons true Latitude may be obtained to any given time; together with hers, and the Suns true horary Motions, and Semidiameters, and Horizontal Parallaxes, by the help of Aſtronomical Tables annexed to this Treatiſe for this purpoſe.

SECTION III.

THE Radixes of the mean Motions are fitted to the Meridian of *London*, and the Noon preceding the firſt of *January*. The Solar Numbers are derived from ſome very late, and accurate Celeſtial Obſervations. The Lunar, are grounded on that *Syſtem of Mr. Horrox*, publiſhed with his *Poſthumous Works* ſome Eight years ſince; but in theſe the Author found it neceſſary to make ſeveral Alterations. He noted then that the Heavens would not admit of any ſuch *Equation of time* as the Learned *Kepler*, and Mr. *Horrox* after had made uſe off; This therefore he has here laid by, and ſubſtituted in its room a Table of *Phyſical Parts* to the ſame effect: the *mean Motions* he found neceſſary to amend; as alſo the *Moons Diameters*, to render them agreeable to his Obſervations, but her *Horizontal Parallaxes* he retains the ſame he formerly made uſe of.

For the ease and Conveniency of Calculation, he has made the Radixes only to every 20 years, from 1581 to 1681; but thence to 1701 for every single year; before the Expiration of which term, he hopes from those many *Lunar* and other Observations he has made, and may hereafter obtain, to find such farther Corrections for these *Numbers*, as may render them more agreeable unto the *Heavens*.

For he will not dissemble it, that tho he esteems these far better than any yet published; he is sensible the *Solar* may be some little faulty, but scarce more than a Minute; the *Lunar* he finds often to Err 5 or 6 Minutes, and sometimes (tho rarely, and at most) 10 or 11 Minutes; which yet he can the easilier bear, whilst he sees the Numbers of other more *famous and celebrated Men* to Err 15 or 16 Minutes, at the same time when his agree nearly with the *Heavens*.

To render the Calculation of the Moons place the more Commodious, he has here given the *Equations* of her *Orbit*, not only under her *Greatest*, *and least Excentricities*, as formerly, but also under *the Mean*; and the *Mean Motions of the Luminaries* to every day of each Month in the year.

To Calculate the Suns true place to any given time by these Numbers.

1. In the third Table entituled *A Table of the Mean Motions*, &c. seek the given year in the first Column on the left hand, if you find it not, write down the next less, with the Residue of years to the given, the Month and Day together, with the Hour and Minute, under each other, and against them in the same order the Mean Motions of the Sun and Perihelion, standing against the said times in the Third Fourth and Fifth Tables.

2. Add the Mean Motions into one Sum, as also the Motions of the Perihelion to its Radical place, so have you the *Suns Mean place*, as also the *Mean Longitude of the Perihelion*.

3. Subtract the Longitude of the *Perihelion* from the *Mean Motion*, the Residue is the *Mean Anomalie*.

4. With the *Mean Anomalie* thus found enter the Sixth Table, intituled *A Table of the Equations of the Earths Orbit*, and finding the Signe in the Head, and Degree in the first Column on the left hand, if it were less than 6 Signes; but otherways, the Sign in the Foot, and the Degree in the utmost right hand Column; against it in the Area take out the *Equation*, by making proportion where requisite: This if the *Mean Anomalie* were less than 6 Signes, subtracted from, but if more added to the *Mean Motion*, gives *the Suns true place*, if the time given were the *Mean* or *Equal*.

5. But if the time given were the Apparent, as it is most Commonly, the place thus found will need a Correction. Enter therefore the First Table with the Suns Mean Anomalie, (as you did before the Sixth for the Equation of the Orbit) and thence take out the Equation of time standing against it, noting whether it be to be added or subtracted.

Again with the Suns true place enter the Second Table, and take the Minutes and Seconds standing against it, noting also their Quality, this is the second part of the Equation.

If

If both these shall be of the same Denomination, that is both to be added or both to be subtracted, their Sum, but if otherways, their Difference shall be the *Absolute Equation of Time*, which according to the Quality of the greater part ought to have been added or subtracted from the apparent time, if given, that so the Calculation might have been fitted to the Mean, as the Numbers require.

But since the Equation of Days could not be found without the Mean Anomalie and Suns place, these being attained we must seek a Correction. Enter therefore the Seventeenth Table with the Mean Anomalie, and against it in the Column entituled the *Earths true horary Motion*, take out the true hourly Motion of the Earth, then say,

As one hour or 60 Minutes, *to* the hourly Motion: *So* the *absolute Equation of time*, *to* the *Proportional Correction.*

Which if the Absolute Equation of Days were Additional, added to, otherways subtracted from the Suns place first found, gives his *true place* to the time proposed.

The following Example will explain these precepts; Let it be required to find the Suns true place in the year 1668, *October* the 25th. at 1 h. 5′ 30″, apparent time under the Meridian of *London*.

The year proposed is Leap-year, therefore I take the Mean Motion belonging to the 26th. of *October*, for the 25th. and the Calculation stands as follows.

	Mean Motion.				*Perihelion.*				
	°	′	″		°	′	″		
1661	09	20	25	46	03	06	35	00	
7	11	29	18	48		5	50		
							41		
October 25th. Biffex.	09	24	42	30					
1 Hour			2	28	03	06	41	31	Perihelion
5 Minutes				12	07	14	29	45	Mean Motion
30 Seconds				1	04	07	48	14	Mean Anomaly
Mean Motion	07	14	29	45	With the Earths Mean Ano. fub.			6′	8″
Equation subtracted		1	32	01	Suns place			9	51
Suns place	07	12	57	44	Absolute Equation of Days fub.			15	59
Parts proport. sub.				40	Suns horary Motion			2	31
Suns correct place	♏	12	57	04	Parts proportional subtract				40

To Calculate the Moons true place at all times.

1. To the given time get the Suns true place and Equation of Days, according to the preceding directions, this added to, or subtracted from the apparent time, gives the true mean time.

2. In the Seventh Table seek the given year, if you find it not, write down the next less therein, with the Residue of years to the given, the Month, and day together, with the hour, Minute, and Seconds; and the several Mean Motions, and places of the Apoge and Node against them, as in the following Example.

3. Collect the Sum of the Moons Mean Motions, as also of her Apoge severally, but for her Node, draw a Line under the Radical place to the year first found, and adding the Motions under it into one Sum, subtract that from the Radical place, so have you the Mean Motions of the Moon, her Apoge, and Node.

4. With the Suns Mean Anomalie enter the Tenth Table, Entituled *A Table of Physical Parts*, and thence take out the Physical parts, standing against it, these according to their Title added to or subtracted from the Moons Mean Motion, give her *Mean Motion correct*.

5. From the Suns true place subtract the Mean Motion of the Apoge, the Residue I call the *Annual Argument*; with which entring the Eleventh Table take thence the Equation of the Apoge; this according to its Title added to or subtracted from the *Mean* place of the Apoge gives the true: In the same Table also with the Annual Argument take out the Excentricitie, which if it be less than the Mean (5°2'37") subtract from it, if bigger take the Mean out of it, and note the difference.

6. From the Mean Motion of the Moon *correct*, subtract the true place of the Apoge, the remainder is the *Mean Anomalie*; with which entring the Twelfth Table Entituled, *A Table of the Equations of the Moons Center*, take the *Equation* answering to it under the *middle Excentricitie*, as also, if the true Excentricitie were more than the Mean, under the greatest, if less, under the least; Note their difference, then say, As 11617½, *to this difference: So the difference of the middle and true Excentricities, to the part proportional.* This if the true Excentricitie were greater than the middle, added to the Equation found under it, otherways subtracted from it, leaves the *true Equation of the Orbit*, which according to its Title, added to, or subtracted from the Moons correct mean Motion, gives her *Equated place.*

7. From the Moons *Equated place*, subtract the Suns; and with the difference in the Thirteenth Table, find the *Variation*, this according to its Title added to, or subtracted from the Moon's Equated place, leaves her *true place in her Orbit.*

8. From the Suns true place subtract the Mean Motion of the Node, the remainer *is the distance of the Sun from the Node*, with which entring the Fourteenth Table take out the *Equation of the Node*, this according to its Title added to, or subtracted from its Mean Motion, makes *its true place.* In the same Table also find the *inclination of the Limit above* 5 *degrees*, or the greatest Latitude of the Moons Orbit at that time.

9. From the Moons true place in her Orbit, subtract the true place of the Node, what remains is the *Argument of Latitude*, with which entring the Sixteenth Table find *the Reduction* with the *Excess*; then say, *As* 18°, *to the Excess; So the inclination of the Limit, or Excess of the Moons greatest*

Latitude

Latitude above 5 Degrees, to the part proportional; which added to the simple *Reduction* makes the true; and this according to its Title added to, or subtracted from the Moons true place in her Orbit, gives her *true place in the Ecliptick*.

10. For her true Latitude, enter the Fifteenth Table with the Argument of Latitude, and therein find the Moons simple Latitude, with the Excess or Increment, when the Inclination of her Orbit is 5° 18'; then say, *As 18' is to the Increment; So the Excess or Inclination of the Orbit above 5 Degrees, to the part Proportional*; which added to her *simple Latitude*, makes the *true*.

Or having the Argument of Latitude, and the Inclination of the Moons Orbit; the *Reduction* and her present *Latitude* may be found perhaps more easily by these proportions.

As the Radius,
To the Co-sine of the Inclination of her Orbit;
So the Tangent of the Argument of Latitude,
To the Tangent of her Longitude from the Node in the Ecliptick.

Whose difference from the Argument of Latitude shall be the Reduction, which if the Argument of Latitude were in the first or third Quadrants, subtracted, otherways added to the Moons place in her Orbit, makes her place in the Ecliptick. For her Latitude,

As the Radius,
To the sine of the true Inclination of her Orbit;
So the sine of the Argument of Latitude,
To the sine of her true Latitude.

To find the Moons Horizontal Parallax, and Semidiameter at all times, with her true horary Motion at the Conjunction with or Opposition to the Sun.

In the Seventeenth Table you have given the Moons true horary Motions in Eclipses, with her Horizontal Parallaxes, and Semidiameters, under the least and greatest Excentricities, to every 6 Degrees of Mean Anomaly, noted in the outside Columns of the Table, by the sixth precept foregoing you may find the Excentricitie, from which subtract the least, and note their difference.

Then if the Moons true horary Motion were demanded, enter the said Table with the Mean Anomaly, and in the Columns of horary Motions take out the horary Motions answering to it under each Excentricitie, note their difference, then say, *As* 23235, (the difference of the least and greatest Excentricities) *to the difference of the horary Motions found; So the difference noted betwixt the present and least Excentricitie to the part proportional*; which if the horary Motion under the least Excentricitie, were less than that found under the greater, added to the Motion under the least, otherways subtracted from it, makes the hourly Motion of the Moon from the Sun, at the time of the Conjunction or opposition. After the same manner would the Horizontal Parallax, and Semidiameter be obtained, if demanded, and therefore I need not give any farther directions for finding them.

To

To explain these precepts by an Example, let it be propoſed to find the Moons true place and Latitude, her Horizontal Parallax and Semidiameter, in the preſent year 1680. on the 22th. of *December*, at 6 h. 30′ time apparent Afternoon under the Meridian of *London*.

The Suns Mean Anomalie will then be 63. 3° 7′ 3″, his true correct place ♑ 12° 09′ 35″, therefore the Equation of time 4′ 57″ to be added to the apparent, which makes the true Mean time 6 h. 34′ 57″ *p.m.*, to which according to the preceding Directions I collect the Mean Motions, and Equations, as follows,

	Mean Motion.	*Apoge.*	*Node Retrog.*	
	☽ ° ′ ″	☽ ° ′ ″	☽ ° ′ ″	
1661	01 18 10 14	5 00 21 51	6 21 04 47	Radical place of the Node. ☊
19	11 21 00 07	1 23 03 29	0 07 27 20	
December 22B	23 58 22	1 09 46 22	18 54 39	
h. 6	3 17 39	1 40	4 8	
′ 34	18 40	10	5	
″ 57	31			
		8 03 43 32	0 26 22 32	Motion of the ☊ from the Radix.
Mean Motion	02 06 45 35	9 12 09 35	9 24 42 15	☊ true place.
Phyſical parts ſub.	1 03	1 08 56 03	Annual Argument.	
		10 50 32	Equat. of the	Apoge add.
Mean Motion Cor.	02 06 44 30			
Apoge	08 14 04 04	8 14 04 04	True place	of the Apoge.
Mean Anomaly	05 22 40 26	Ex. 57678	Eq. under the	Greateſt Excen. 01 03 52 ⎫ Diff. 12′ 1″
Equation ſubtract.	54 22	M. Ex. 55237		Mean Excentr 00 51 51 ⎭
☽ Equation place	02 05 50 08	Diff. 2441		Parc propo. add 00 02 31
Suns	09 12 09 35			Abſolute Equat. 00 54 22
☽ from the Sun	04 23 40 33	☊ Mean pla.	5 24 42 15	R. c. s. 5 01 36 9,998327
Variation ſubtract	36 16	Suns	9 12 09 35	t. 71 29 22 10,475214
☽ in her Orb	02 05 13 52	☽ from the ☊	3 17 27 20	t. 71 25 22 10,473541
Node	05 23 44 30	Equat. ☊ ſub.	57 45	Red. ſub. 4 00
Argument of Lat.	08 11 29 22	☊ true place	5 23 44 30	R. s. 5 01 36 8,942600
Reduction Subtra.	4 00	In. of the Orb	5 01 36	s. 71 29 22 9,976930
☽ place in the Eclip.	♊ 05 09 52			s. 4 45 58 8,919530
Latitude South	04 45 58			
Moons Horiz. Paral.	61 31	Hence the M. true place is ♊ 5 09 52		
Horizontal Semid.	16 4	Latitude South 4 45 58		

The place of the Bulls South Eye is at this time ♊ 5° 19′, its Latitude South 5° 30′: So that the Moon may cover it in ſeveral places of the Earth; how the application to it will appear in our or any other Horizon I ſhall ſhew hereafter; at preſent it will be neceſſary to direct you how to find the time of the true Conjunctions or Oppoſitions of the Luminaries, and to Conſtruct their Eclipſes; after which, the Conſtruction of Appulſes will be eaſie.

SECT.

SECTION IV.

To find the time of the Mean Conjunction or Oppositon of the Sun and Moon.

1. TO the Year and Month in which the *Mean Conjunction* or *Oppositon* of the Luminaries is required, in the Twentieth Table, Entituled, *A Table of the Mean Motions of the Moon from the Sun*, Collect the middle Motions of the Moon from the Sun; take the Complement of this to 12 Signes, and from it or the Opposition (which if required, may be made by the Addition of 6 Signes to it) continually subtracting the nearest lesser Mean Motions, the answerable Days, Hours, Minutes, and Seconds; will shew the time of the *Mean Conjunction* or *Oppositon* of the Sun and Moon.

For Example.

I desire to know the time of the *Mean Conjunction or New Moon* which will happen in *July* 1684.

	Moon from the Sun.			
	ˢ	°	′	″
1681	08	11	09	13
3	00	28	52	07
July	01	16	31	32
Motion of the ☽ from the Sun	10	26	32	52
Complement	01	03	27	08
Days 2	00	24	22	32
	00	00	04	15
Hours 17	00	08	38	06
	00	00	26	09
Minutes 51	00	00	25	54
Seconds 29	00	00	00	15

Therefore the Mean time of *the Mean Conjunction of the* Luminaries in *July* 1684. will happen *July* the first at 17 h. 51′ 29″ Afternoon, for the given year is *Leap-year*.

To

To find the time of the true Conjunction or Oppoſition of the Sun or Moon.

1. To the time of the *Mean Conjunction* or *Oppoſition* Calculate the true Longitude of the Sun from the Vernal Equinox, and of the Moon in her Orbit by the Directions of the laſt foregoing Section: If theſe be found exactly the ſame, or Oppoſite, the times of the *Mean and true Conjunction and Oppoſition are the ſame*, but if, as commonly it happens, they differ, then,

2. Note the difference, and with the Mean Anomalies of the Sun and Moon, (the Moons being firſt Corrected by the Addition or Subtraction of about half ſo much as ſhe wants of, or is paſt the ☌ or ☍) enter the Seventeenth Table, Entituled, *A Table of the Moons true hourly Motions*, &c. and in the ſecond Column take out the Earths, by the third and fourth, get the Moons true hourly Motions, ſubtract the Earths from the Moons,

Then ſay,

As the Difference of the true hourly Motions,
Is to one Hour, or 60 Minutes of time;
So is the Moons Diſtance from the ☌ or ☍ of the Sun,
To the Interval of time betwixt the Mean and true ☌ or ☍, which is always leſs than 14 Hours.

If the Moon were found to want of the *Conjunction or Oppoſition* of the Sun, the *Interval* added, but if ſhe was paſt either of them, ſubtracted from the time of the Mean ☌ or ☍, makes *the Mean or equal time of the true*; to which time again for greater certainty, compute the true places of the Sun, and ☽ in her Orbit, with the Moons Latitude, and the exact Mean time of the true ☌ or ☍, being found.

3. With the Suns Mean Anomalie, and true place, enter the firſt and ſecond Tables, and thence take the *Equation of Natural days* according to the precepts of the laſt Section; this, if it were to have been added to the Apparent time, ſubtracted here; but if to have been ſubtracted, added to the Mean time of the true ☌ or ☍, makes the Apparent time of either in the Moons Orbit.

4. Enter the Nineteenth Table with the Moons true hourly Motion from the Earth, in the head, and the Argument of Latitude in the ſide, againſt them in the common Area you have the time of Reduction, which according to its Title added to, or ſubtracted from the Apparent time of the ☌ or ☍ in the Orbit, leaves the Apparent time of the *neareſt approach of the Moons Center, to the Center of the Diſk in Solar Shadow in Lunar Eclipſes.*

But if the ſame contrary to its Title be added to, or ſubtracted from the Apparent time of the true ☌ or ☍ in the Orbit, it makes the Apparent time of the true Conjunction or Oppoſition in the Ecliptick.

Example.

Example.

1684.	The Mean Conjunction of the Sun and Moon *July* the first		17	51 29
	The Earths Mean Anomalie then	00	14	03 37
	The Annual Argument	02	23	51 16
	The Moons Mean Anomalie	02	20	14 44
	The Suns true place	☌	20	30 50
	The Moons in her Orbit	☌	16	00 46
	The Moon short of the Conjunction	00	04	30 04
	The ☽ hourly Motion (to 2′ 22″½ of Anom.)		33	09
	Suns true hourly Motion		02	28
	☽ true hourly Motion from the Sun		30	37
	Interval add		08	48 46
	Mean time of the true Conjunction in the Orbit, *July* the second	02	44	15
	At which time,			
	The Suns true place is	☌	20	51 52
	The Moons Mean Anomalie	02	26	11 50
	The Excentricitie		43	62
	The Moons true place	☌	20	51 52
	The true place of the ☊	☌	16	30 24
	The Argument of Latitude	04	21	28
	The Moons true hourly Motion	00	33	18
	The Suns 2′ 23″: The Moons from the Sun	00	30	55
	The Equation of days to be subtracted here	00	04	57
	Therefore the apparent time of the ☌ in the Orbit at	02	35	18
	Time of Reduction subtracted	00	02	11
	The apparent time of the neareſt approach of the Moon to the Center of the Disk	02	33	07
	But of the Ecliptical ☌ with the Sun	02	37	29

And the neareſt diſtance of the Moons Center from the Center of the Diſk in her paſſage over it, equal to her Latitude at the time of her Conjunction in the Orbit		′	″
		22	46
The Moons Horizontal Parallax was then		57	44
The Suns ſubtracted from it		00	10
Leaves the Semidiameter of the Diſk		57	34
The Moons Horizontal Semidiameter		15	40
The Suns		15	50
The Semidiameter of the Penumbra		31	30

The Angle of the Moons way with the Ecliptick 5° 41′, this is equal to the Angle which the Perpendicular to her way formes with the Axis of the Ecliptick; and if the Argument of Latitude be more than 9 Signes or leſs than 3, the ſaid Perpendicular lies to the left hand, if more to the right from the Axis of the Ecliptick.

To Calculate the times of the principal appearances of a Solar Eclipſe under the Meridian of LONDON.

1. To the Semidiameter of the Diſk add the Semidiameter of the Penumbra, if the Moons Latitude at the time of the true ☌ in the Orbit be leſs than this Sum, the Sun will appear Eclipſed ſomwhere on the Earth, otherwiſe, not.

And if the ſaid Latitude be leſs than the Semidiameter of the Diſk, the Eclipſe will be Central in ſome places of the Earth, otherwiſe, no where.

Subſtract the Semidiameter of the Penumbra from the Semidiameter of the Diſk, if the Moons Latitude at the time of the Conjunction be leſs than this Reſidue, the intire Penumbra will fall within the Limb of the Diſk otherwiſe not.

2. Convert this difference, the Semidiameter of the Diſk, and the Sum above got, ſeverally into Seconds:

Then ſay,

As the Radius,
To the Moons Latitude in Seconds,
So the Sum of the Semidiameters in Seconds,
To the Co-ſine of the firſt Angle of Incidence.

And, *So is the Semidiameter of the Diſk,*
To the Co-ſine of the ſecond Angle of Incidence.
And, *So is the Difference of the ſaid Semidiameters,*
To the Co-ſine of the third Angle of Incidence.

As the Σ of the Semidiam:
To the Radius
So the D Latitude
To the Coſine of the firſt angle of Incidence
As the Semidiam of the Diſk is
To the Radius
So is the ☾ Latitude
To the Coſine of the
As the Difference of the ſaid Semidiams
To the ☾ Latitude
So the radius
To the Co-ſine of the 3d.
2d Angle

The first Angle of Incidence subtends the Motion of Semiduration of all manner of Eclipses on the Earth; the second the Motion of Semiduration of Central Eclipses; and the last the Motion of Semiduration of the entire Penumbra within the Disk.

Say Again,

As the Radius,
To the sine of the first Angle of Incidence;
So the Sum of the Semidiameters of the Disk and Penumbra,
To the Motion of Semiduration of the whole Eclipses of all sorts.

And, *So the Semidiameter of the Disk,*
To the Motion of Semiduration of Total Eclipses.

And Again,

So the difference of the Semidiameter of the Penumbra and Disk,
To the Motion of the Semiduration of the Penumbra within the Disk, or Semimora.

3. To Convert these Motions into time, say,

As the Moons hourly Motion from the Sun,
To one hour;
So the Motion of any Semiduration,
To the time answering it.

Which subtracted from, or added to the time of the middle Eclipse; or the neareſt approach of the Centers of the Moon and Disk, gives the time under the Meridian of our Tables, when the answerable appearances begin or end in other places of the Earth.

In the first Section of this part you were taught how to find the Angle which the Axis of the Earth formes with the Axis of the Ecliptick; and to know on which hand from the Axis of the Ecliptick it lay in the Projection; how to know on which side the said Axis the Perpendicular to the Moons way lies, you have been shewed before: Note now,

If the *Axis of the Globe*, and the *Perpendicular to the Moons way* be both to the same hand, (that is, both to the right, or both to the left from *the Axis of the Ecliptick*) their difference, but if otherways (that is one on the right, and the other on the left) their Sum shall be the Angle, which the Moons Path over the Disk formes with a Parallel to the Equator. This for brevity, wanting a better Term, I call *the Angle of Direction.*

Which if the Inclination of the Axis of the Globe, be less to the right hand or more to the left, than the Inclination of the *Perpendicular to the Moons way*, to the Axis of the Ecliptick; or if the Axis of the Globe

lying on the left, the Perpendicular fall on the right hand the ſaid Axis of the Ecliptick, *the Angle of Direction ſhall be Affirmative*; but if the ſaid Inclination be leſs to the left hand, or more to the right, than the Inclination of the *Perpendicular*; or if the Perpendicular lying on the left, the Axis of the Globe fall on the right hand the Axis of the Ecliptick, *the ſaid Angle of Direction will be Negative:* Mind theſe Cautions, then ſay,

As the Radius,
To the Tangent of the Angle of Direction;
So the neareſt diſtance of the Centers of the Moon, and Penumbra at the middle of the Eclipſe.
To the Motion betwixt the Axis of the Globe, and the place of the Moons neareſt approach to the Center of the Disk.

Find the time anſwering to this Motion, as you did the time of the Semiduration before; If the Angle of Direction were Negative, this ſubtracted; If Affirmative, added to the Apparent time of the middle, gives the Apparent time at *London*, when the Meridional Sun ſhall be Centrally Eclipſed elſewhere.

Example.

	°	′	″
The Semidiameter of the Disk	00	57	34
The Semidiameter of the Penumbra	00	31	30
Their Sum	01	29	04
Their Difference	00	26	04
The firſt Angle of Incidence	73	11	00
The ſecond	66	42	00
The third	29	08	40
The Motion of Semiduration	01	26	06
Of Semi-centralitie	00	52	52
Of Semi-mora	00	12	41
From the Axis to the neareſt approach	00	01	14

	h	′	″
Hence the time of the Semiduration of all manner of Eclipſes in the Earths Disk	02	47	06
The time of the Semiduration of all the Central Eclipſes in the Earth	01	42	36
The time of the Semi-mora, or the Semiduration of the whole Penumbra within the Disk	00	24	38
The time from the tranſit by the Axis to the middle	00	02	24

By

By Subtracting and adding these severally (all save the last, which is only to be subtracted) to $2^{a}\ 33'\ 0''$ the time of the middle, or neareſt approach of the Moon to the Center of the Disk; I Collect the times at *London*, when,

The Penumbra first touches the Disk and the Eclipse first of all begins in the Earth .	11	46	01	In the Morning.
The Center of the Penumbra enters the Disk and the Central Eclipses begin . . .	00	50	31	Afternoon.
The Mora begins, or the Penumbra is now first wholly within the Disk	02	08	29	
The Meridional Sun Centrally Eclipsed .	02	30	43	
The Nonagesimal Sun Centrally Eclipsed .	02	37	29	
The Mora ends, or the Penumbra begins first to Emerge from the Disk . . .	02	37	45	
The Central Eclipses end in the Earth and the Center of the Penumbra passes off the Disk	04	15	43	
The Penumbra passeth off the Disk, and all Eclipses ended in all places of the Earth .	05	20	13	
After they have continued in passing over the Earth	05	34	12	

At that place where the Penumbra first enters into the Disk, the Sun appears beginning to be Eclipsed in the Supreme Point of his Vertical Diameter; where the Center of the Penumbra enters it, he appears Centrally Eclipsed in his Rising; and the Eclipse ends as he Riseth in the lowest Point of his Vertical Diameter, in that Point of the Earth where the Penumbra is first totally Immerged within it: where the Line of the Moons way intersects the Axis of the Globe he is Centrally Eclipsed in the Meridian, and where it passeth the Axis of the Ecliptick in the Nonagesime degree.

X Vid: pag. 107. Table. Rudolph.

Where the Penumbra first begins to Emerge from the Disk, the Eclipse is beginning in the lower Extremity of his Vertical Diameter as he sets; where it Cuts the Disk again he ~~happens~~ appears Centrally Eclipsed in his setting; and where it wholly leaves the Disk, the Eclipse ends in the upper Extremity of his Vertical Diameter as he passeth the Horizon.

To determin the Latitudes of those places on the Globe, and their Longitudes from London, where any of those appearances happen.

If the Angle of Direction be Negative, subtract it from, otherways add it to the Angles of Incidence; the Residue shall be the Amplitudes of those Paths in the Horizon of the Disk, which the Penumbra touches in its first Entrance, when its Center enters, and when tis first totally within: Add the same Angle to the Angles of Incidence when Negative, subtract it when Affirmative, makes the Amplitudes of those Paths in the Horizon of the Disk, whereon the Penumbra first begins to Emerge from the Disk, where its Center Emerges, and where it last touches it as it passeth off.

Say Then,

As the Radius,
To the sine of the Suns distance from the Pole;
So the Co-sine of the Amplitude of any Path,
To the Co-sine of its Latitude.

Which if the Amplitude of the Path be less than 90 Degrees, is North of the Equator, otherways, South:

Say Again,

As the Co-sine of the Suns distance from the Pole,
To a Radius;
So the Tangent of the Amplitude of any Path,
To the Tangent of the hour of Sun Rise, or Sun Set in that Latitude,

Which if the Suns distance from the Pole be less than 90 Degrees and the Latitude North; or more than 90, and the Latitude South, is to be accounted from Midnight, otherways from Noon.

But to find in what Latitude the Meridional Sun shall be Centrally Eclipsed.

Say First,

As the Co-sine of the Angle of Direction,
To a Radius,
So the Moons distance from the Center of the Disk in the middle of the Eclipse,
To the distance in the Axis.

And Again,

As the Semidiameter of the Disk,
To the sine of 90 Degrees;
So the Distance of the Moons Center from the Center of the Disk, as she passeth over the Axis of the Globe.
To the sine of the Arch of the Meridian betwixt the Sun and Vertex.

Which

Which if the Moons Latitude at the ☌ were North, ſubtracted from, if South added to the Suns diſtance from the Pole of the Globe, makes the diſtance of the Point on the Earth from the ſaid Pole, of which, if leſs than 90 degrees, the Complement to 90 is the Latitude North; if more the exceſs ſhews the Latitude South.

And if the Arch of the Earth be more than the Suns diſtance from the Pole, the Pole it ſelf is Eclipſed, and the Complement of the Latitude ſhall be their difference.

Take the Sum and difference of the Moons diſtance from the Center of the Diſk, and the Semidiameter of the Penumbra, work by the ſame Proportion, and you will find the Arches of the Earth anſwering to them, and the places where the Meridional Sun was touched, either on his upper or under Limbe by the Moon as ſhe paſſed by him.

If the place where the Moon ſhall be Centrally Eclipſed in the Nonageſime degree be required, having her diſtance from the Center of the Diſk, ſhe tranſits the Axis of the Ecliptick;

You may ſay again,

As the Semidiameter of the Diſk,
To a Radius;
So the Moons diſtance from the Center of the Diſk in her tranſit,
To the ſine of the Suns diſtance from the Vertex in the Nonageſime. Which obtained,

Say,

As the Radius,
To the Co-ſine of the Inclination of the Axis of the Earths Globe to the Axis of the Ecliptick;
So the Tangent of the Suns diſtance from the Vertex,
To the Tangent of a fourth Arch, which taken from the Suns diſtance from the Pole leaves a fifth.

Say Now,

As the Co-ſine of the fourth Arch,
To the Co-ſine of the fifth;
So the Co-ſine of the Suns diſtance from the Vertex,
To the ſine of the Latitude of the place.

Say again,

As the ſine of a fifth Arch,
To the ſine of the fourth;
So the Tangent of the Inclination of the Axis,
To the Tangent of the hour from Noon when the Sun will be in the Nonageſime.

Note,

Note, that if the Axis of the Globe be to the right hand from the Axis of the Ecliptick, the hour is before Noon, if to the left, Afternoon.

For Example.

	°	′	″
The Inclination of the Axis of the Globe to the right hand from the Axis of the Ecliptick in the Disk	08	48	00
The Angle which the Perpendicular to the Moons way formes on the right hand with the Axis of the Ecliptick	05	41	00
Their difference the Angle of Direction Negative	03	07	00
Which therefore subtracted from the first Angle of Incidence	75	11	00
Leaves the Amplitude of that Path of that Vertex in the Horizon of the Disk, which the Penumbra first touches in its entrance	72	04	00
Hence the Latitude of that place	16	36	Nor.

The time of the Suns rising there	05	32	31
The time then at *London*	11	46	01
The Difference equal to the Difference of Meridians	06	13	30

	°	′
And the place to the West of *London*,	93	22½

Where the Eclipse first begins at Sun Rise, in which Latitude and Longitude from *London*, lies the Golf of *Honduras* in *America*, where the Eclipse will begin in the Suns upper Limb as he Riseth.

	°	′	″
The Angle of Direction	03	07	00
Contrary to its Title added to the Angle of Incidence	75	11	00
Makes the Amplitude of that Path in the Disk which the Penumbra last touches, when it leaves the Earth	78	18	00
Hence the Latitude of that Point	10	51	Sou.

The time of the Suns set there	06	17	39
The hour at *London* then Afternoon	05	20	13
The difference equal to the difference of Meridians	00	57	26

	°	′	″
Therefore the place to the East of *London*	14	21	30

Under

Under which Position lies *Zanfara* in *Egypt*, where about the Eclipse will be seen ending in the Supreme part of the Suns Vertical Diameter as he Sets. *Where the Eclipse last ends at Sun Set.*

The second Angle of Incidence is		66	42 00
The Angle of Direction Subtract		03	07 00
The Amplitude of that Path which the Center of the Penumbra touches, when it enters the Disk		63	35 00
Hence the Latitude of the place		24	23 Nor.
	h ′ ″		
The time of the Suns Rise in that Latitude	05	18	05
The time at *London* then Afternoon	09	50	31
The Difference of Meridians	07	32	26
Therefore the place to the West of *London*		113	06 30

Which position agrees with *New Spain* in *America*, where the Sun will be Centrally Eclipsed at his Rising. *Where the Sun Rises Centrally Eclipsed.*

The Sum of the second Angle of Incidence and Direction make the Amplitude of that Path which the Center of the Penumbra last touches, when it leaves the Disk		69	49 00
The Latitude therefore of that Point North		18	40 00
The time of Sun Set in that Latitude	06	31	11
The time then at *London* Afternoon	04	13	43
The Difference of Meridians	02	17	28
The place therefore to the East of *London*		33	52 00

Under which Position lie the Southern parts of *Egypt*, where the Sun Sets centrally Eclipsed. *Where the Sun Sets Centrally Eclipsed.*

The Difference of the Angle of Direction, and third Angle of Incidence, makes the Amplitude of the Path of that Verter in the Horizon of the Disk, which the Penumbra last touches when tis Totally immersed in it, 26° 01′

Hence the Latitude of that Point			56 30
	h ′ ″		
Time of Sun Rise in that Latitude at	03	30	39
Time then at *London* Afternoon	02	08	29
The Difference of Meridians	19	37	50
And the place to the West of *London*		159	27½

Where the Eclipse ends at Sun Rise.

The place under this Latitude and Longitude from *London*, falls in the Western Ocean, to the West of *the Streights of Anian*, (if any such) and there the Eclipse ends at Sun Rise, in the lowest Point of his Vertical Diameter, this is the most Western place that sees the Eclipse.

	°	′	″
The Sum of the Angle of Direction and the third Angle of Incidence makes the Amplitude of the Path of that Vertex whereon the Penumbra first begins to Emerge from the Disk	32	15	00
Therefore the Latitude of that place	51	43	
	h	′	″
The time of Sun Set there	08	02	12
The hour then at *London* Afternoon	02	57	45
The Difference of Meridians betwixt *London* and it	05	04	27
Therefore the place to the East of *London*			76 07

Where the Eclipse begins at Sun Set.

Under which Position on the Globe lie the Southern parts of *Caracathay*, where the Eclipse begins in the lowest Point of the Suns Vertical Diameter, as he Sets, this is the most Eastern of all those places where any part of the Eclipse of the Sun is seen.

	°	′	″
The distance of the Penumbra from the Center of the Disk in the place where the Path intersects the Axis	00	22	48
The Arch in the Meridian of the Earth under it is		23	19
The Suns distance from the Pole		68	08
Their Difference, or the Complement of the Latitude		44	49
Therefore the Latitude North		45	11
	h	′	″
Time there is Noon, at *London* Afternoon	02	30	43
So the place to the West of *London*		37	41

Where the Sun is Centrally Eclipsed in the Meridian.

And the Sun Centrally Eclipsed in the Western Ocean about the *Azores*, in the Meridian, or at Noon.

	°	′	″
The Sum of the Semidiameter of the Penumbra and the distance of its Center from the Center of the Disk in its passage	00	54	14
The Arch in the Meridian answering it		70	24
Exceeds the Suns distance from the Pole		02	16

Where the Suns lower is just touched by the Moons upper Limb, in the Meridian.

The Eclipse therefore extends beyond the Pole, and in the Latitude of 87° 44′, the Moons upper Limb just touches the lower Limb of the Sun in the Northern Meridian.

The Semidiameter of the Penumbra exceeds the distance of the Moons Center, from the Center of the Disk in her passage over the Axis	°	′	″
	00	08	46
The Arch of the Meridian answering it *South of the Sun*	08	45	
Added to the Suns distance from the Pole makes	76	53	
Therefore the Latitude North	15	07	

Where under the same Meridian passing a little to the West of the *Azores*, the Northern Limb of the Sun is just touched by the Moons Southern, which place falls in the Western Ocean betwixt the Islands of *Cape Verde* and the *Caribee's*.

Where the Penumbra touches the Suns Northern Limb in the Meridian.

The distance betwixt the Center of the Disk, and the place where the Moons Path intersects the Axis of the Ecliptick is	°	′	″
	00	22	52
The Arch of the Earths Globe under it		23	25

The time when the Center of the Moon passeth it	h	′	″
Afternoon	00	19	41
The time at *London* then Afternoon	02	37	29
The Difference of Meridians	02	17	48

Therefore the place to the West of *London*		34	27
The Latitude of that place		45	04

Where the Nonagesimal Sun is Centrally Eclipsed; that is something more Westerly than the place where he was Centrally Eclipsed in the Meridian.

Where the Sun is Centrally Eclipsed in the Nonagesime or highest Point of the Ecliptick.

SECTION V.

THat the reason of the foregoing Calculus of the General Phases of a Solar Eclipse may be evident to the Ingenious Reader; I shall here shew how this may be represented by an easy Delineation in *Plano*.

Let ⊙ represent the Center of the Disk, take ⊙B from a Scale of equal parts, or from the Line of Lines on a Sector, equal to its Semidiameter 57′34″, and therewith letting one Foot of the Compasses on ⊙, strike a Circle; this shall represent the *Limb* or *Horizon of the Disk*, projected on a Plane Coincident with the Moons way, at right Angles with the Line Connecting the Centers of the Sun and Earth. *Fig. 7.*

Through ⊙ draw the Diameter ϱ⊙ϖ continuing it both ways without the Disk. This shall be the Line I call *the Axis of the Ecliptick*, and the Point ϱ where it Intersects the upper part of the Limb of the Disk its *Northern Pole*.

From the ſame Scale of equal parts, or the ſame Line of Lines on the Sector open to the ſame Angle, take off the Semidiameter of the Penumbra 31′ 30″, and ſet it off on the Axis of the Ecliptick from *e* to *A* and *x*, through which Points, with one Foot of the Compaſſes on the Center ⊙, ſtrike Circles; the Semidiameter of the Larger ⊙A ſhall be 01° 26′ 04″ *the Sums*, ⊙*x* 26′ 04″ *the difference of the Semidiameters of the Disk and Penumbra*.

The Inclination of the Perpendicular to the Moons way to the Axis of the Ecliptick, I have before determined 05° 41′ on the right hand. Make therefore ⊙*e* (the Semidiameter of the Disk) the Radius of a Line of Chords, and taking from the ſame, the Chord of the Inclination 05° 41′, ſet it off from *e* the Pole of the Ecliptick to *z* that way; from the Center ⊙ draw the Line ⊙*z*, this ſhall be *the ſaid Perpendicular to the Moons way*.

From the forementioned Scale of equal parts take 22′ 46″, the neareſt diſtance of the Line of the Moons way from the Center of the Disk, which if North, as here, ſet it off in the ſaid Line from ⊙ to *m* Northwards (otherways on the contrary ſide the Center towards A) through *m* draw the Line *n m f* at right Angles to ⊙*z*, this ſhall be the *Line of the Moons way over the Disk, or the Path of the Penumbra*.

To the Points *n k r u q* and *f*, where the Path of the Penumbra interſects the Circles before deſcribed, draw ſtreight Lines from the Center ⊙, producing ⊙*r* and ⊙*u* till they reach the Limb of the Disk in *r* and *s*, ſo have you in the Antecedent Limb of the Disk, Firſt the Point *n*, the place of the Moons Center, when the Penumbra firſt touches the Limb of the Disk in *b*, whence the Riſing Sun appears beginning to be firſt Eclipſed in the ſupreme Point of his Vertical Diameter: Secondly the Point *k*, where the Center of the Penumbra enters the Disk, and the Sun appears Centrally Eclipſed in his Riſing: Thirdly *r*, the place of the Moons Center, when the Penumbra is got wholly within the Disk, and *r* the place in it where the Eclipſe at that time ends, in the loweſt Point of the Suns Vertical Diameter, as he Riſeth: Fourthly N the Point under which the Sun is Centrally Eclipſed in the Nonageſime, or totally if the Suns Semidiameter be leſs than the Moons. And in the Conſequent Semi-Circle; Fifthly *v* the place of the Moons Center when the Penumbra begins to Emerge from the Disk, and *s* the Point in the Disk where it Emerges, and whence the Eclipſe appears beginning in the Suns loweſt Limb, as he Sets: Sixthly *q*, where the Center of the Penumbra Emerges from the Disk, and the Sun appears Centrally Eclipſed in his Setting: Seventhly *f*, the place of the Moons Center when the Penumbra leaves the Disk, and *g* the Point whereon it Emerges, the Eclipſe ending there in the Vertical Point of the Setting Sun.

And now we have formed three pair of Triangles: Firſt, *m* ⊙ *n* = *m* ⊙ *f*, in which is given ⊙*n* = ⊙*f* the Sum of the Semidiameters of the Penumbra and Disk, and ⊙*m* the neareſt diſtance of the Path of the Penumbra from the Center of the Disk, and the Angle at *m* right; to find *m* ⊙ *n* = *m* ⊙ *f* *the firſt Angle of Incidence*, with *m n* = *m f* *the Motion of the Semidiameter of all manner of Eclipſes*, which will be eaſily obtained by the forementioned proportions.

Secondly, In the Triangles $mk\odot = mq\odot$, are given $\odot k = \odot q$ the Semidiameter of the Disk, with $m\odot$ as before, to find $mk\odot$ *the second Angle of Incidence* equal to $mq\odot$; and $mk = mq$ *the Motion of the Semi-duration of Central Eclipses.* mok moq;

Thirdly, In the Triangles $mv\odot = mr\odot$, are known $\odot t = \odot v$, the Difference of the Semidiameters of the Disk and Penumbra with $\odot m$, as before; whence $mt\odot = mv\odot$, *the third Angle of Incidence*, $mt = mv =$ *the Motion of Semimora* will be eaſily had; which Arches $mt = mf$, $mk = mq$, $mr = mv$, being turned into time, and the times anſwering them ſubtracted from and added to the middle of the Eclipſe, or the Moment the Center of the Penumbra is at m, gives the ſeveral times when the ſaid Center ſhall be at $nktvqf$, or the times of general Phaſes of the Eclipſe belonging to thoſe places at *London*. $mot = mov$.

Or the time when the Center of the Penumbra ſhall arrive at the ſaid Points, may be otherways Mechanically inveſtigated thus. The middle of the Eclipſe, or the time when the Moons Center will be at m, happens at 33′07″ paſt two a Clock Afternoon: Say, As 1 *Hour or* 60 *Minutes*, to 30′55″ *the hourly Motion of the Moon from the Sun*: So *is* 33′07″ *the time more than* 2 *Hours Afternoon*, to 17′02″ *the Motion from* 2 *a Clock to the middle.*

From the ſame Scale wherewith you laid off the Semidiameter of the Disk 57′$\frac{12}{60}$, take 17′$\frac{02}{60}$ of the ſame parts betwixt your Compaſſes, and ſetting one foot on m, with the other make a Point in the Line of the Moons way on the Right-hand; this ſhall be the place of the Center of the Penumbra at 2 a Clock Afternoon at *London*, and is therefore noted here with the Number II.

The hourly Motion of the Moon from the Sun, is 30′55″, take therefore from the ſame Scale of equal parts 30′$\frac{55}{60}$ betwixt your Compaſſes, and ſetting one Foot on II, with the other make Points on each ſide it in the Line of the Moons way; theſe ſhall ſhew the place of her Center in it at the hours of I and III: And if from theſe Points you farther ſet off the ſaid extent, in the ſaid Line you may thereby find the place of the Moon in the ſame Line for every hour, whilſt the Penumbra ſhall touch the Disk: Divide the ſpace betwixt every hour into 60 parts, ſo have you the place of the ☽ Center in the Line of her way to every ſingle Minute of time.

After this manner was the Line of the Moons way drawn and divided in the Eighth Figure, whereby the times when the Moons Center comes upon any of the forementioned Points, will be found the ſame as by Calculation.

The Angle mon is equal to the Arch zb, mok to zk, and mos to zr; to each of which the Arch ez (which according to *Kepler* is not more than 5° 18′) in the Caſe before us being added, makes the Arches eb, ek, er, but ſubtracted from them gives eg, eq, es the Altitudes of the Nonageſime Degree in thoſe places at Sun Riſe or Sun Set; with which and the Suns true place or the oppoſite Point, as the Caſe happens, that Ingenious Perſon entring his Nonageſimary Table finds the Latitude of the Points

bkrigg, and thence the right Aſcenſion of the Midheaven at the time of the Sun Riſing or Setting in thoſe places, whoſe difference from the right Aſcenſion of the Midheaven when the Penumbra is on any of the ſaid Points under the Meridian of his Tables, gives the Longitude of thoſe places thence, to the Eaſt if it were more, to the Weſt if leſs than the right Aſcenſion of the Midheaven at the place to which his Number are fitted.

It was I conceive the greateſt ſucceſs which the diligent Endeavours of this Famous Perſon met with in Correcting of the Planetary Motions, that cauſed him to employ the greateſt part of his time and pains about them; ſo that having found how the uſual Imaginary Circles of the Sphere might be projected in the Copernican Syſtem, and all the Diurnal Appearances of the Sun and Stars ſalved by them; he contented himſelf to ſhew this, and never enquired how they were Naturally formed, and might be more eaſily repreſented without the help of any ſuch Fictitious Circles; as I have before ſhewn; elſe he had never miſt of a better Method, whereby without the help of any Nonageſimary Table, the Latitudes and Longitudes of thoſe places on the Earth from the Meridian of his Tables, where the principal Appearances of a Solar Eclipſe ſhall happen might be inveſtigated, and which I ſhall here ſhew.

Fig. 7. The Inclination of the Earths Axis to the Axis of the Ecliptick, I have allready found in the firſt Section of this part 8° 48′ on the right hand; ſet off accordingly 8° 48′ in the Limb of the Diſk, from *e* the Pole of the Ecliptick on the right hand to *i*, and by the Point ſo found draw the Line *i*⊙*a* through the Center of the Ecliptick, this ſhall be the Axis of the Earth projected in it.

The Inclination of the Perpendicular to the Moons way to the Axis of the Ecliptick, I have before determined 5° 41′ to the ſame hand equal to the Arch *ez* which taken away from *ei*, leaves *zi* equal to *z*⊙*i* *the Angle of Direction* 3° 07′.

Which according to the Cautions of the Preceding Section is Negative, and therefore ſubtracted from the Arch *zb* leaves *ib* the Amplitude of that Path in the Horizon of the Diſk whence the Eclipſe is ſeen beginning in the Vertical Point of the Riſing Sun; from *zk*, leaves *ik* the Amplitude of that Path whence the Eclipſe is ſeen Central at Sun Riſe; but taken from *zr*, the Reſidue *ir* will be the Amplitude of that, wherein the Eclipſe ends in the loweſt Point of the Riſing Sun.

But if on the Contrary the Arch *zn* be added to *zi*, it makes *in* the Amplitude of the Path, whence the Eclipſe is ſeen beginning in the loweſt Limb of the Setting Sun; to *zq* it gives *iq*, the like Amplitude of the Path of that Vertex, in which the Eclipſe appears Central at Sun-ſet; but added to *zg*, the Sum *ig* will be the Amplitude of that Path, in which the Eclipſe ends in the higheſt Point of the Suns upper Limb as he Sets.

In the ſame Seventh Figure let P repreſent the North Pole of the Globe, whoſe place in the Axis is determin'd by the directions of the firſt Section; from which Imagin Hour-circles drawn to *bkrigg* in the Diſk; the Angles which thoſe Hour-circles ſhall form with the proper Meridian ⊙P, ſhall be

be the hours at which the Sun rises or sets in any of those Paths, and the Arch of any Meridian betwixt the Pole and any of the said Points shall be the distance of the Path from the Pole, or the Complement of the Latitude of the place upon that Point. Let B in the Eighth Figure represent any of the said Points, and let the Hour-circle PB be drawn; In the Right-angled Triangle PBi are given, Pi the Complement of the Suns distance from the Pole equal to the Reflection, iB the Amplitude of the Path, and the Angle at i right, whence either PB the Distance of the Path from the Pole, or BPi the hour of Sun rise or set will be found by the known Resolutions of Right-angled Triangles; which last whether it be to be Numbred from Noon or Midnight, the cautions of the last Section teach. Fig. 8.

To find the place where the Sun will be Centrally Eclipsed in the Meridian: In the small Triangle m⊙p are given m⊙ as before, m⊙p the Angle of Direction, with the Right Angle at m, whence the Arch mp intercepted betwixt the Earths Axis, and the Perpendicular to the Moons way, and consequently the time betwixt the Meridional Eclipse, and the middle will be found, as also ⊙p, and the Arch of the Globe under it; Say, *As i⊙ . i 90° :: ⊙p : to the sine of the Arch of the Earths Globe under it*; which in this Case subtracted from ⊙P leaves PB, the Complement of that Latitude, under which the Sun is Centrally Eclipsed in the Meridian.

The Semidiameter of the Penumbra is 31' 30", ⊙p 22' 48" added to it makes 54' 18"; subtracted from it leaves 8' 42", which converted into Arches on the Earth by the foregoing Ratiocination, and those added to, and subtracted from the Suns Distance from the Pole ⊙P, makes the Complements of those Latitudes, wherein the Suns under and upper Limb are onely touched by the ☽ in her Transit, as in the Example.

But if the Time when, and the place where the Moon shall appear totally Eclipsed in the Nonagesime Degree be required, in the Triangle N m⊙ Right-angled at ⊙, are known the Angle N⊙m which the Perpendicular to the Moons Path makes with the Axis of the Ecliptick, and the Angle at m right, whence the Motion betwixt the middle, and the Transit of the Axis of the Ecliptick Nm, will be easily found, together with N⊙, and the Arch of the Earths Periphery under it. m

Imagin an Arch of an Hour-circle PN struck through the Pole and this Point N, then in the Oblique-angled Triangle NP⊙ are known the Arch N⊙, the Distance of the Nonagesimal Sun from the Vertex, ⊙P the Suns Distance from the Pole, with the Angle ⊙NP the Inclination of the Axis of the Globe to the Axis of the Ecliptick, whence NP the Complement of the Latitude, or the distance of the Vertex, where the Sun is Centrally Eclipsed in the Nonagesime, from the said Pole; together with the Angle NP⊙, or the hour (Afternoon in this Case) when the Sun shall be in the Nonagesime will be had. NOP

After the same manner it might easily be determin'd under what Latitudes and Longitudes from the Meridian of our Tables, the Suns upper or under Limb should be only touched by the Moons in the Nonagesime Degree, or more Points might be found on the Globe, through which a Line drawn

shews

shews all the places where the Eclipse would appear Central, or the greatest nearly of any given Number of Digits.

If it were required to know the Longitude of that *place* from *London*, and its Latitude, where the Sun shall be Centrally Eclipsed, when 'tis here two hours Afternoon, the time proposed is 33' 07" before the middle of the Eclipse at *London*: Say then, As 1 *Hour* to 30' 55" *the hourly Motion*: So 33' 07" to 17' 02", *the Motion from* 2 *Hours Afternoon, to the middle, or from* II to *m*.

To II draw the streight Line ⊙II; then in the Triangle *m* ⊙ II, are given *m* ⊙ and *m* II, whence the Angle *m* ⊙ II will be found 36° 48'; and ⊙ II 28' 26"; but the Arch of the Earths Periphery under it 29° 36', the Distance of the Vertex under that Point from the Sun.

From the Pole P, let the Arch of an Hour-circle be drawn through II; so in the Oblique-angled Spherical Triangle ⊙ P II are known, ⊙ P the Suns Distance from the Pole 63° 08', which ⊙ II the Suns Distance from the Vertex 29° 36', and the Angle Interjacent P ⊙ II 36° 48", whence P II the Complement of the Latitude will be found 46° 18'; therefore the Latitude of that Point 43° 42' North.

But the Angle ⊙ P II, or the hour before Noon 24° 09' ½ = to 1h 36' 38", the true time therefore at that place will be 10h 23' 22" in the Morning, which taken from 2 hours Afternoon leaves 3h 36' 38" = 54° 09' ½, the Longitude of that place to the West from *London*.

SECTION VI.

TO determin the Apparent Time of the beginning or end of Solar Eclipse, the Time when the Sun shall be Eclipsed to any possible Number of Digits, the Inclination of the Cusps of the Eclipse, and the Time of the visible Conjunction of the Luminaries in any given Latitude.

In the first Section of this part, I have shewed how the *Path of any Vertex* may be described in the Disk, and for an Example, I have delineated the Path of the Vertex of *London*, at the time of this Eclipse of the Sun in the Eighth Figure which is the Ellipsis *d m f*.

In the foregoing or Fifth Section I have shewed how the Line of the Moons way, or Path of the Penumbra may be drawn and divided, which is also done according to the precepts there delivered, in the said Figure Eight.

In the same Figure I have drawn two other Paths, the middle L E O for the Latitude of 36° 03' North, which will fit *Aleppo* and all other places under that Latitude; the other I A B for the Latitude of 17° 36' North, under which lies the Island of *Jamaica*, where I desire to know at what time the Beginning of this Eclipse, the visible Conjunction of the Luminaries, and the End of it will happen.

Take

Take betwixt your Compaſſes the Semidiameter of the Penumbra 31′ 30″, from a Scale of ſuch equal parts as the Semidiameter of the Diſk was ſet off or meaſured by, that is $57\frac{18}{20}$, and carrying one Foot along the Line of the Moons way from the right hand to the left, find a Point in it, upon which if that Foot be ſet the other turn'd about ſhall Cut the ſame hour in the Path of the Vertex that this ſtands upon: The Point in the Path upon which the fixed Foot then ſtands ſhall ſhew the time of the beginning of the Eclipſe.

Carry on the ſame Foot of your Compaſſes ſtill more to the left hand, and find another Point in the Line of the Moons way, whereon if you fix one Point of your Compaſſes, the other ſhall cut the ſame hour in the Path of the Vertex which this ſtands upon in the Line of the Moons way, the Point on which your Compaſſes ſtand ſhall ſhew the Minute the Eclipſe ends, if the Scheme admit Minute Diviſions.

By the help of a Square of which one ſide may be apply'd and carried cloſe along the Ecliptick ♈ H, another Point may be found in the Path of the Vertex, whence a Line drawn by the Perpendicular edge of the Square, ſhall cut the ſame time in the Line of the Moons way, it marks in the ſaid Path of the Vertex; this ſhall be the time of the viſible Conjunction of the Luminaries.

Thus carrying the Semidiameter of the Penumbra betwixt my Compaſſes with one Foot in the Line of the Moons way, I find that when it comes to ♒ at 8′ after II hours, the other if turn'd about will cut the ſame time in the Path of the Vertex at ♑, this therefore is the time of the beginning of the Eclipſe at *London*.

Draw the Line ♒♑, and from ⊙ the Line ⊙♑, this ſhall repreſent the Vertical Circle; and the Angle ⊙♑♒ which theſe two Lines form ſhall be the Angle which the Vertical Circle ſhall make with the Line connecting the Centers of the Sun and Moon at the beginning of the Eclipſe.

If the Compaſſes be kept at the ſame extent, and one Point carried forward in the Path of the Penumbra, when it comes to ♈ at $26\frac{1}{2}$ paſt IIII, the other Point turn'd about will cut the ſame hour in the Path of the Vertex at ♉, wherefore the Eclipſe then ends at *London*.

Draw ♈♉, and from the Center of the Diſk ⊙♉, the Angle ⊙♉♈ ſhall be that which the Vertical Circle ſhall form with the Line connecting the the Center of the Luminaries, at the end of the Eclipſe.

And if the edge of a true Square be carried cloſe along the Line H♈, when the Perpendicular ſide cuts the Path of the Penumbra in ☍ at 21 after III, it alſo cuts the ſame hour in the Path of the Vertex at ♋, this therefore is the time of the viſible Conjunction, ♋ the place of the Vertex or the Suns Center, ☍ the Moons place in her Orbit.

Take the Semidiameter of the Sun from the ſame Scale, whereby you laid off the Semidiameter of the Diſk, betwixt your Compaſſes, and therewith on the Center ♋ deſcribe a Circle, this ſhall repreſent the Sun, and with the Moons Semidiameter betwixt your Compaſſes taken from the ſame Scale, on the Center ☍ deſcribe another Circle, this ſhall cut off from the

former so much as the Sun shall be Eclipsed at the time of the visible Conjunction.

From ⊙ draw the Line ⊙ ♈, this shall represent the Vertical Circle, ♈ the Vertical Point in the Sun, whereby the position of the Cusps of the Eclipse in respect of the Perpendicular through the Suns Center, are plainly and easily obteined.

Produce ♈ ⊙ till it intersect the Moons Limb in θ, then shall ⊙θ the greatest distance of the Limbs of the Sun and Moon, be the parts Eclipsed, which if the Suns Diameter be divided into 12 equal parts shall be equal to 7⅓ of them, and so many are the Digits Eclipsed at the greatest Obscuration nearly.

Hence at London,

	h.	m.
The beginning of the Eclipse *July* 2ª 1684. at	02	08 Afternoon,
The visible Conjunction of the Luminaries	03	21 Digits then 7⅓;
The end	04	26⅓.

And the position of these Appearances in respect of the Vertical Circle passing the Suns Center, as in the Ninth Figure.

If it were required to know at what time the Eclipse shall begin and end at *Aleppo*; the Arch of the Ellipsis L E Q is the Path of that place, and the Path of the Penumbra is the same for all places of the Earth.

But the Times will be to be Numbred differently in it, according to the Difference of the Meridian of any place from *London*, for if the place given lie to the East, the hours in the Moons Path will be to be reckoned so much more; if to the West so much less, as is the difference of Meridians.

Aleppo is usual accounted 02ʰ 20′ to the East of *London*, the middle therefore which at *London* will be 2ʰ 33′ 07″ Afternoon, shall be 04ʰ 53′ 07″ Afternoon at *Aleppo*, and all the hours marked in the Path will be accounted 02ʰ 20′ more than they are noted, with the large Figures.

Wherefore on the upper side of the Line of the Moons way, I have noted in small Figures the place of her Center in the Path at every hour, so that hence it will be easy to find her place in the Path to any Minute required.

And now carrying the Semidiameter of the Penumbra, betwixt my Compasses along the Line of her way; I find that when one Foot comes to ♑ at 05 h. 19′ reckoned for *Aleppo*, the other will cut the same hour in the Path of the Vertex at ♑, this therefore I pronounce the time of the beginning of the Eclipse there.

And when the same carried on comes to ♒ at 6 h. 17′½, there a Line drawn Parallel to the Axis of the Ecliptick, or Perpendicular to the Ecliptick it self will cut the same hour in the Path of the Vertex at ♒, this therefore is the time of the visible Conjunction of the Luminaries, the distance of their Centers then ♒.

Carrying the same Foot of the Compasses at the same extent forward along the Line of the Moons way, I find that when at 07 h. 08′ the same

Foot

Foot ſtands upon *s*, the other cuts the ſame hour in the Path of the Vertex where it interſects the Limb of the Diſk, this therefore I conclude the end of the Eclipſe, juſt at Sun-ſet.

Therefore at Aleppo,

	h.	m.	
The beginning of the Eclipſe	05	19½	Afternoon,
Viſible Conjunction	06	17½	Digits then 7;
End at Sun-ſet	07	08.	

And the bearing of each of theſe Appearances as in the Tenth Figure.

If the time of theſe Phaſes at *Jamaica* be demanded the Arch of the Ellipſis I A B repreſents the Path of that place, whoſe Meridian is accounted 5 hours to the Weſt of ours, ſo that when 'tis Noon with us, tis to the Inhabitants there only 7 a Clock in the Morning: and the middle of the Eclipſe, which with us is at 2 h. 33′ Afternoon, to them will be at 9 h. 33′ before Noon; Wherefore on the under ſide of the Line of the Moons way, I have noted the hours 5 leſs than at *London*, ſo that the Diviſions Numbred by them ſhew the place of the Moons Center to any given time during the Eclipſe at *Jamaica*.

Let the Semidiameter of the Penumbra be carried along this Line as in the foregoing Examples, the ſtanding Foot being at μ upon 6 h. 55′½ in the Path of the Penumbra, the other at γ will cut the ſame hour in the Path of the Vertex; a Line drawn from σ at 08 h. 05′ will cut the ſame hour in the Path of the Vertex at τ, the diſtance of the Centers of the ☉ and ☽ at that time being σ τ: And if with the Compaſſes at the former extent we ſeek another Point in the Line of the Moons way, whereon if one Foot ſtanding, the other turn'd about will cut the ſame time in the Path of the Vertex; we ſhall find it at ξ at 08 h. 59′, and the place of the Vertex at ο.

Wherefore at Jamaica,

	h.	m.	
The beginning at	06	55	in the Morning,
The viſible Conjunction	08	05	Digits then 4⅓;
The End	08	59.	

And the poſition of theſe appearances as in the Eleventh Figure.

If it be required at what time any poſſible Number of Minutes or Digits, ſhall be Eclipſed in the Suns Antecedent or Conſequent Limb at any Place; Let the Suns Diameter be accordingly divided into Minutes or Digits, and ſubtracting or Cutting off the parts required to be Eclipſed from the Semidiameter of the Penumbra, take the remaining part of it betwixt your Compaſſes, and carrying it along the Line of the Moons way find the firſt Point in it, on which placing the one Foot, the other turn'd about will Cut the ſame hour the fixed Foot ſtands upon; the hour and Minute in the Path on which the fixed Foot ſtands ſhall be the time of that

Obscuration. If for Example it were demanded at what time 3 Digits, or one fourth part of the Suns Diameter, should be Eclipsed in his Antecedent Limb at *London*; cutting off $\frac{1}{4}$ of the Suns Semidiameter from the Semidiameter of the Penumbra, and carrying the rest as directed, I find it 2^h $29' \frac{1}{2}$ in the Line of the Moons way, when the one Point of the Compasses standing on that Time, the other will cut the same accounted in the Path of the Vertex; and therefore this shall be the time of that Eclipse in the Suns Antecedent Limb at *London*.

Whence we have a very ready way given for finding the Difference of Meridians betwixt any two places, whose Latitudes are known, from the like Observation of the same Solar Eclipse, which will not be difficult if the time and quantity of the Eclipse observed under the Meridian of the Tables, shall happen to be the same the Calculus and Construction shews; for suppose the Eclipse shall happen as it is predicted at *London*; but at *Jamaica* the end shall appear at 9^h 20′ in the Morning; the place of the Vertex in the Path of *Jamaica* at that time will be found at ν, take the Semidiameter of the Penumbra betwixt the Compasses and setting one Foot on ν, with the other strike an Arch cross the Line of the Moons way at γ, this cuts it 2^h 4′ Afternoon at *London*; which shall be 9^h 20′ in the Morning at *Jamaica*, therefore the difference of Meridians betwixt *Jamaica* and *London* (if it shall so happen) will be the difference of these Times, that is onely 4 h. 44′.

But if the Time at *London* shall be found different from what the Calculation has given, and the Digits Eclipsed more or less than it represents, the Latitude of the Path $\odot m$ must be made more or less accordingly; till the Digits Eclipsed at the visible Conjunction shall be found the same with what the Observation requires.

For the Semidiameter of the Disk, the Suns, and Moons; with their hourly Motions are found by Experience so nearly agreeable to Observation, that they will admit of little or no alteration, the sensible defects of our Tables are only in the Moons Latitude and place, of which the first being correct, the latter may also be easily amended.

For the Latitude of any place being given, and the time of the beginning, end, or any Phases of an Eclipse, the place of the Vertex in the Disk at that time, may be laid down by the Method of the first Section.

The Semidiameter of the Penumbra, or the parts of it not Eclipsed, if some Appearance were given, may be made by taking the parts deficient from the Semidiameter of the Penumbra.

Then taking it or the remaining parts betwixt your Compasses, set one foot on the Point of the Vertex, and turning the other about make a stroke through the Line of the Moons way, the Point there Cut shall be the place of the Moons Center at that time, whence the Line of the Moons way may be divided.

And then the time of any Appearance, in a distant place whose Latitude is known, being given, the difference of Meridians betwixt that, and the Meridian of the Tables, or any other known place will be easily found, as the difference of Meridians betwixt *Jamaica* and *London*: The Method I confess requires much Caution, but if duly Considered, it will be easily understood, and put in practice by the Ingenious observer.

SECT.

SECTION VII.

AS the beginning, Digits obſcured, and end of a Solar Eclipſe; So alſo the Occultation of any Fixed Star by the Moon, its Emerſion from her, or the diſtance of her Center from it when not covered by her, at the time of their Elliptical Conjunction, may be determined by Conſtruction; only, remembring what I have before intimated, that by reaſon both the Parallaxes and Semidiameters of the fixed Stars are ſmall and almoſt inſenſible, the Moons Horizontal Parallax ſhall be the Semidiameter of the Diſk; and her Semidiameter, the Semidiameter of the Penumbra.

And for the Conſtruction of theſe as of Solar Eclipſes will be required:

1. The true time of the Ecliptical Conjunction of the Moon and Star.
2. The Angle of the Moons way with the Ecliptick, or which the Axis of her Orbit formes with the Axis of the Ecliptick.
3. The difference of the true Latitudes of the Moons Center, and the Star to which ſhe applys at the time of the Ecliptical Conjunction.
4. The Stars Right Aſcenſion and diſtance from the Pole of the Globe.
5. The Inclination of the Axis of the Earths Globe, to the Axis of the Ecliptick in the Diſk.

1. To find the firſt in any given Year and Month; make the Mean Motions of the Moon to that Year and Month, by the help of the Table of the Moons mean Motions, which ſubtract from the true Longitude of the Star at the given Time, from the Reſidue ſubtract the next leſſer middle Motion under the Month of *January* in the Eighth Table; and from what remains, the next leſſer middle Motions found in the Ninth Table continually till nothing be left; the Days, Hours, Minutes and Seconds ſtanding againſt the middle Motions, ſo ſubtracted, ſhall be the true time of the Mean Conjunction of the Moon and Star.

2. To this Time calculate the Moons true place in the Ecliptick by the Directions of the Third Section, which if it happen to be the ſame with the Stars, the time of the Mean and True Conjunction are the ſame, but if, as commonly, they differ; then,

Note the difference, and if the Moons true place be found ſhort of the Stars, add; if paſt, ſubtract about twice as many Hours and Minutes, to or from the time of the Mean Conjunction, as ſhe is Degrees and Minutes ſhort or paſt the Star; and to the time thus made Calculate her true Longitude in the Ecliptick, betwixt which, and the Stars true place note the Difference:

Then you may ſay,

As the differences of the places of the Moon Calculated to theſe two times,
To the difference of the ſaid times,
So the difference betwixt the place of the Moon and the Star laſt Calculated,
To the interval of time betwixt the laſt Calculation, and the time of the true Conjunction.

If

If the Moons place found by the last Calculation were less than the Stars, add the interval to; if more, subtract it from the Time to which the last Calculation was made; that Sum or Difference shall be the true equal Time of the Conjunction of the Moon and Star; which by the Equation of Days may be Converted into the Apparent.

But this Method being tedious, I have most commonly made use of another, which besides that it is more Expeditious, will be found to have some other Conveniencies in it above the preceding.

The Moons true places Calculated either from *Tycho's*, or *Kepler's* Numbers I find to agree much better with my own, than any other; From these the places of the Moon are given in *Eichstadius* or *Hockers Ephemerides* for years past; in *Argolus's* for years to come till 1700.

Entring therefore the Ephemerides of that Month in which you desire to know at what time the Moon will be in Conjunction with any Star, you will readily see on what Day her places at Noon will be next less and more than the Stars, the difference betwixt those two places at Noon are her Diurnal Motion. Subtract her place at Noon next less than the Stars, from its true place, so have you their difference:

Say Then,

As the Diurnal Motion, to this difference,
So are 24 hours or one day;
To the time of the Conjunction of the Moon and Star, Afternoon, under the Meridian of the Ephemerides.

The Meridian of *Rome*, to which *Argolus* his Ephemerides are fitted, lies 1 hour nearly to the East of *London*; therefore from the time thus obteined subtract one hour, so have you the time of the Conjunction of the Moon and Star under the Meridian of *London*.

To which if you Calculate the Moons true place by the Tables herewith published, as also to 2 hours either before, or after, as you judge most Convenient, you will have the Moons Motion in 2 hours given, by which and the difference of hers and the Stars true Longitudes at either of the times, you may find the true time of their Conjunction. To get her Latitude at which time,

In the Calculation of the Moons place you will have given the Inclination of her Orbit to the Ecliptick, with the true place of her Node.

Subtract the place of the Node from the Longitude of the Star, the Residue is the Argument of Latitude:

Say Then,

As the Radius,
To the Tangent of Inclination of her Orbit;
So the Sine of the Argument of Latitude,
To the Tangent of the Moons true Latitude at the time of the true Conjunction.

Which

Which if the Argument of Latitude be less than 6 Signes is North, if more South.

And if the Moons Latitude at the time of the true Conjunction be more to the North, or less to the South than the Stars, the Moons Center in her transit by the Star passeth as much to the North of it, as is their difference, but if otherways, as much to the South:

Again,

As the Radius,
To the Sine of the Inclination of the Orbit;
So the Co-sine of the Argument of Latitude,
To the sine of the Angle of the Moons way with the Ecliptick.

Or which the Axis of her Orbit formes with the Ecliptick, from which it lies to the Right-hand, when the Argument of Latitude is more than 9 Signes, or under 3; but to the left when the said Argument is more than 3 Signes, or less than 9.

The Longitudes of the Stars from the first Point of ♈ with its Latitude being given, its distance from the Pole and Right Ascension may be got by the Directions of the 14 Section of the First Part, or more easily, and exact enough for our purpose, by the Tables of Declination and Right Ascension Printed herewith, from the beginning to page 37, which being obtained it will hold.

As the Co-sine of the Stars Latitude,
To the Co-sine of its Right Ascension from the next Equinoctial Point,
So the sine of the distance of the Poles of the Globe and Ecliptick,
To the sine of the Inclination of the Earths Axis to the Ecliptick.

Which if the Longitude of the Star be in ♈ ♉ ♊ ♋ ♌ ♍ is to the Left, if in any of the other 6 Signes to the Right-hand from the Axis of the Ecliptick.

As in the Construction of the Solar Eclipse, the Plane upon which the Projection was drawn was supposed to stand at Right-angles to the Line Connecting the Centers of the Sun and Earth, coincident with the Moons Orbit; so in the Stellar Eclipse we must suppose it to coincede with the Moons way at Right-angles to the Line Connecting the Centers of the Earth and Star, and that Lines produced from the Star to Infinite Points in the Horizon of the Earths Disk, her Axis, the Axis of the Ecliptick, and the Path of any Vertex, will project them all in the same Plane.

Having shown before how this projection may be represented and delineated in *Plano*, I shall not need here to repeat any directions concerning it, but seeing the Path of the Vertex, and Line of the Moons way over the Disk may be divided several ways; I shall only teach one, which in my opinion seems the most convenient for our purpose.

When

When the Vertex passeth the Axis of the Globe projected in the Disk, the Star Transits the Meridian; I call *that time the Sidereal Noon*, and mark the intersection with *e*; the hours on each side it projected in the Path I number by their distances from it: 1, 2, 3, 4, 5, 6, *&c.* as in the Twelfth Figure, those on the Right-hand being *Negative*, and shewing the Star short of the Meridian; those on the Left *Affirmative*, and shewing it past.

Having got the Apparent time of the true Ecliptical Conjunction, turn it into Degrees and Minutes; get the Suns Right Ascension at the same time. Add these together, the Sum shall be the Right Ascension of the Midheaven, which if it be less than the Stars Right Ascension subtracted from it, leaves an Arch, which turn'd into time gives *the time before the Sidereal Noon, at which the Moons Center shall Transit the Axis of the Ecliptick.*

But if the Right Ascension of the Midheaven be greater than the Stars, subtract this from that, the Residue converted into time, will give *the Sidereal hour Afternoon of the said Transit.*

Diminish the Moons true horary Motion by the 365th part of it self, the Residue is the *Sidereal horary Motion of the Moon:*

Say Then,

As 1 Hour or 60 Minutes,
To the Sidereal horary Motion;
So the Minutes and Seconds above any hour, at which the Ecliptical Conjunction happens,
To the Motion answering it.

Take this Motion betwixt your Compasses from the Scale of Minutes or equal parts, and setting one Foot on that Point where the Line of the Moons way intersects the Axis of the Ecliptick, with the other make a Point on the said Line; if the time of the Conjunction were before the Sidereal Noon, on the Left-hand; if after it, on the Right; this shall be the place of the Moons Center at the said hour.

Take the Moons Sidereal horary Motion betwixt your Compasses from the said Scale of Minutes, and setting one Foot on the Point last made, transfer the distance in the said Line to and fro, making as many more Points at the said Distance from each other as you shall find convenient, these shall be the places of the Moons Center at other hours: Divide each hour space into 60 equal parts, so have you the place of the Moons Center to every Minute of the Sidereal hour, which if the time of the Ecliptical Conjunction were before the Sidereal Noon, are to be Numbred successively from the Left-hand to the Right, as in the Twelfth Figure; but if after it, the contrary way, or from the Right-hand to the Left.

Taking the Semidiameter of the Moon betwixt your Compasses from the Scale of Minutes, carry one Point along the Line of the Moons way, till the other turn'd about will first cut the same time in the Path of the Vertex,

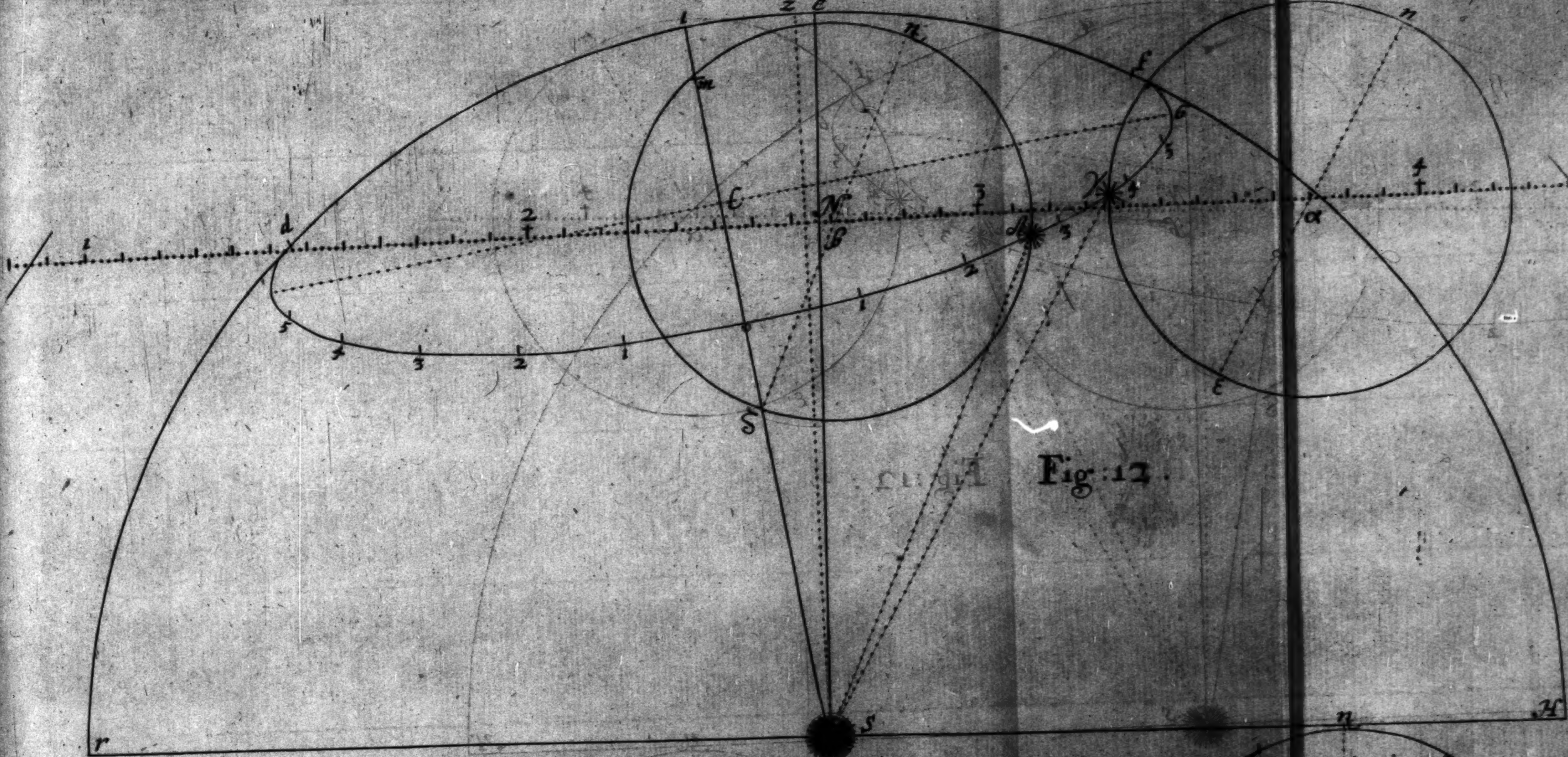
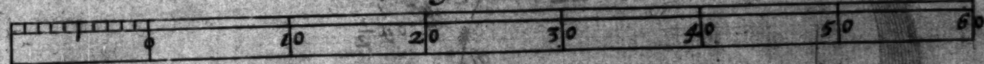


Fig: 12.

A Scale of Minutes



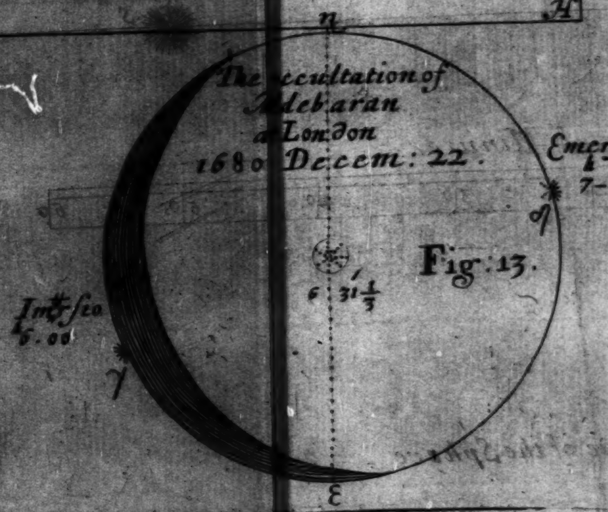


Fig: 13.

between page 66 and 67 the Doctrine of the Sphere.

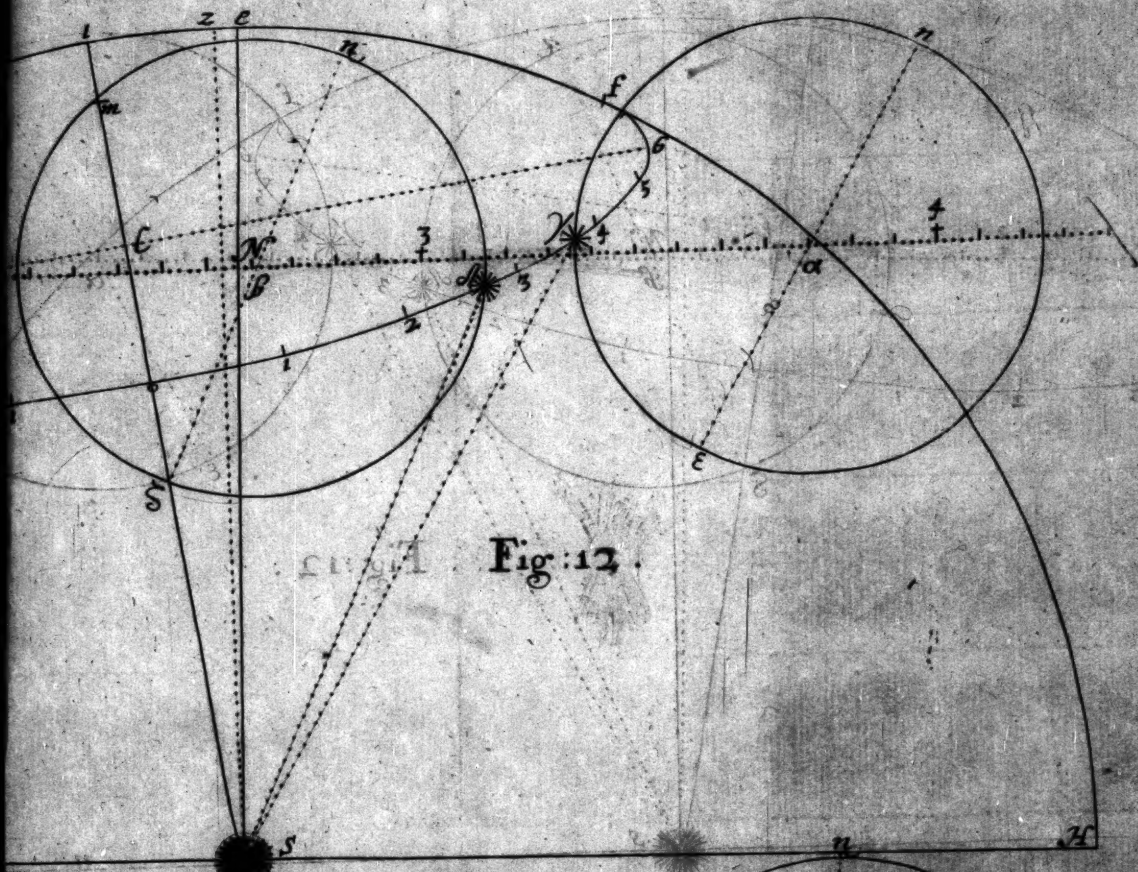

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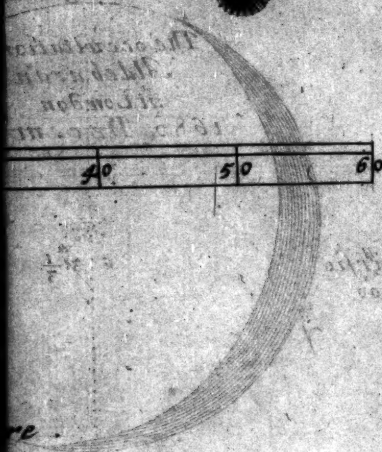
Fig: 12.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The occultation of
Aldebaran
at London
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7-04 1/2
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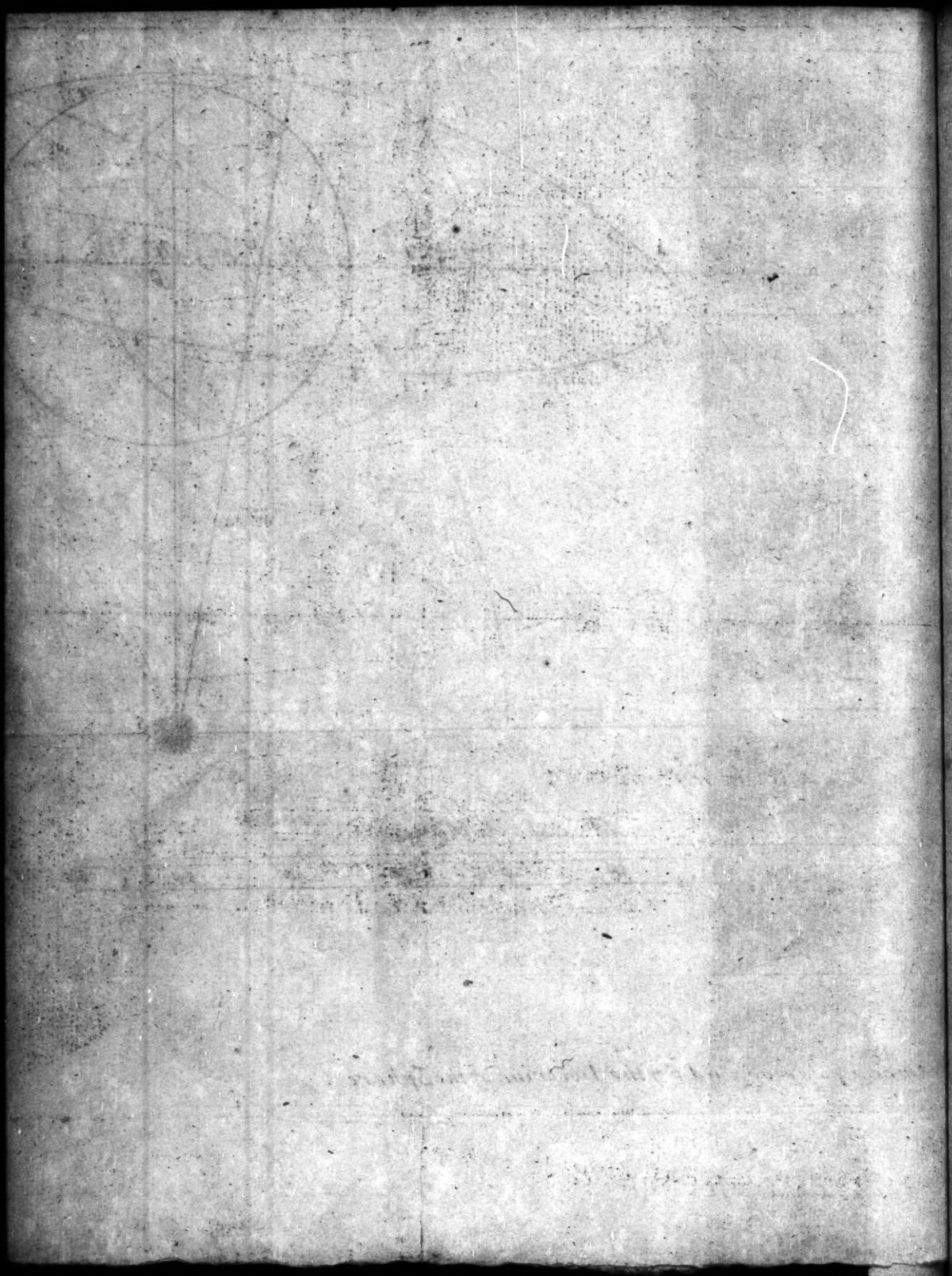
6.00
6 31 1/3

Fig: 13.



Vertex, if before the Sidereal Noon in the hours on the Right-hand the Axis of the Globe, if after it, on the Left; the Point on which the fixed Foot then ſtands, ſhall be the place of the Moons Center, and ſhall ſhew the Sidereal hour from Noon at which the Star ſhall be covered by the Moon.

In like manner carrying the Foot of the Compaſſes, forward or from the Right-hand to the Left, find another Point in the ſaid Line, on which one Foot of the Compaſſes being ſet, the other turn'd about will cut the ſame hour in the Path of the Vertex, this ſhall be the place of the Moons Center and Sidereal hour from Noon at which ſhe ſhall uncover the Star, or of its Emerſion from her.

Subtract the Suns Right Aſcenſion from the Stars, the remainer turn'd into time, ſhall give the time of *the Stars Culmination*, or when it Tranſits the Meridian.

If the Sidereal hour of the Stars Occultation or Emerſion were before the Sidereal Noon, ſubtract it from the time of the Stars Culmination; if it were after, add them together, ſo have you the true times of the Stars Occultation and Emerſion.

But if the time of the viſible Conjunction of the Moons Center and the Star, or ſome other, which ſhe ſhall not cover, be required, find a Point in the Line of the Moons way, whence a Line drawn Parallel to the Axis of the Ecliptick, ſhall cut the ſame hour in the Path of the Vertex that it touches in the Line of her way, this ſhall be the Sidereal hour of the viſible Conjunction; whence the Solar may be derived as before directed.

Take the Moons Semidiameter betwixt your Compaſſes from the Scale of Minutes, and ſetting one Foot on the Point ſo found in the Line of her way, with the other deſcribe a Circle, this ſhall repreſent her Disk, and the diſtance of the neareſt part of it from the Vertex at that time meaſured on the Scale of equal Parts or Minutes, will ſhew how many Minutes the Moons next Limb will be diſtant from the Star at the time of the viſible Conjunction.

The following Example will make theſe directions eaſily underſtood.

If it be required to know at what time the Moon will be in Conjunction with *Aldebaran*, or the Southern Eye of the Bull, in *December* this inſtant Year, 1680.

The place of the Star will be then ♉ 5° 19′ 26″, its Latitude South 5° 30′ 6″; And by the Ephemerides the Moon will be in the ſame Longitude on the 22 of *December*, at 6ʰ 30′ Afternoon at *London*.

	°	′	″
The Moons true place then by my Tables ♉ . . .	05	08	42
but at 2 hours after, or at 8ʰ 30′ in ♉ . .	06	24	28
Therefore the Moons true Motion in 2 hours . .	01	14	56
and her true horary Motion	00	37	28
Moons place at 6 Hours 30 Minutes in Antecedence of the Star	00	09	48

Therefore the Apparent Time of the Ecliptical Conjunction at *London*, $6^h\ 45'\ 42''$ Afternoon.

	s	°	′	″
The Inclination of the Moons Orbit then . .	00	05	01	49
The true place of the Node	05	23	44	00
The Argument of Latitude	08	11	25	20

Therefore,

The Inclination of the Axis of the Moons Orbit to the Axis of the Ecliptick on the left hand *ze* .	01	36	00	
The Moons Latitude South	04	46	03	
Fig. 12. Less than the Stars . . . . . * N	00	44	07	

	°	′	″	
The Inclination of the Axis of the Ecliptick to the Axis of the Globe on the left hand, *ei*, ...	09	57	30	
The Stars distance from the North Pole of the Globe	74	11	30	
Difference of it and the Complement of the Latitude	35	39	00	*a.*
Sum of it and the said Comp. 112° 4′, Comp. to 180°	67	16	30	*m.*

Time of the ☌ $6^h\ 45'\ 42''$, converted into deg. and min. makes	101	25	30
Sun then in ♑ 12° 10′ ½; his Right Ascension	283	15	00
The Right Ascension of the Midheaven, Subtract . . .	24	40	30
The Right Ascension of *Aldebaran*	64	24	30
The Sidereal hour of the Conjunction, before the Sidereal Noon.	39	44	00
Or in time $2^h\ 38'\ 56''$.			

The Right Ascension of the Sun 283° 15′ Subtracted from the Right Ascension of the Star 64° 24′½, leaves 141° 09′½, which converted into Time gives $9^h\ 44'\ 38''$½, the time of its Culmination or Southing.

	′	″
The Moons Sidereal horary Motion	37	19
Her Motion in $38'\ 56''$ of Time	24	13

To be laid off in the Line of the Moons way from its interfection with the Axis of the Ecliptick to the left hand.

In the Twelfth Figure, having drawn the Semicircle *r e* H, let it repreſent one half of the Earths Disk, *e* ✳ the Axis of the Ecliptick; from *e* ſet off *e z* on the Left-hand = 1° 36′, and *e i* 9° 57′½: draw the Line ✳ *z*, it ſhall repreſent the Axis of the Moons Orbit in the Disk, and ✳ *i* the Axis of the Globe.

If making ✳ *i* the Radius of a Line of Sines, you take the Sine of 35° 39′, and ſet it off in the Axis of the Globe from ✳ to *o*, and the Sine of 67° 16′½ from ✳ to *m*, the middle betwixt theſe Points C will be the Center of the Ellipſis repreſenting the Path, and C *o* = C *m* its Conjugate Semidiameter.

Through C ſtrike a Line at Right-angles to the Axis of the Globe, and therein ſet off the Sine of 38° 32′ the Complement of the Latitude, from C both ways; this ſhall be the Conjugate Semidiameter of the Ellipſis repreſenting the ſaid Path of the *Obſervatory*, which may now be deſcribed, and the hour Points laid down in it, as in the Projection for the Eclipſe, but the hours numbred as was laſt directed.

The Moons Horizontal Parallax will be 61′ 31″, her Horizontal Semidiameter 16′ 41″: Make a Scale of ſuch equal parts, as that ✳ *i* the Radius of the Disk may be 61 $\frac{1}{60}$, (ſuch a one I have drawn under the Twelfth Figure) take there from 44 $\frac{22}{60}$, the Moons Latitude from the Star to the North, and ſet it off in the Axis of the Ecliptick from ✳ to N, through which Point draw the Line 4 N *t* at Right-angles to ✳ *z*, this ſhall be the Line of the Moons way.

The Moon paſſeth the Axis of the Ecliptick, or will be in Conjunction with the Star 38′ 56″ more than 2 hours before the Star will paſs the Meridian; the Moons Sidereal Motion in that time is 24′ $\frac{22}{60}$; taking therefore 24′ $\frac{1}{60}$ from the Scale of Minutes betwixt your Compaſſes, and ſetting one Foot on N the interſection of the Moons way, and the Axis of the Ecliptick, transfer the ſaid diſtance in the Line of the Moons way, (becauſe the Conjunction happens before the Culmination of the Star) on the Left-hand, it ſhall give the place of the Moons Center 2 hours before the Sidereal Noon, or the Culmination of the Star.

From the ſame Scale of Minutes taking 37 $\frac{23}{60}$ the Moons Sidereal horary Motion, and ſetting one Foot of the Compaſſes on 2, with the other make Points in the ſaid Line, and carrying the ſaid Extent from 3 on the Right-hand, it gives the Point 4; ſo have we got the Place of the Moons Center at 4, 3, 2, and 1 hours before the Star Tranſits the Meridian.

Dividing the ſpaces betwixt each of theſe into 60 equal parts, as in the Figure, we have the place of the Moons Center to every ſingle Sidereal Minute of the Intermediate Time.

Taking the Moons Semidiameter betwixt your Compaſſes, and carrying one Foot along the Line of the Moons way thus divided; when it comes to ♑ at 3ʰ 44′¼, the other Foot turn'd about will cut the ſame time in the Path of the Vertex; this therefore is the time before the Culmination of the Star, at which it will be covered by the Moons preceding Limb; and carrying the ſaid Foot unto ♐ at 2ʰ 40′¼ the other turn'd about again cuts the ſame

hour in the Path of the Vertex, and therefore the Emersion of the Star will be 2h 40′½ before it cross the Meridian.

If now from 9h 44′½ the time of the Stars Culmination, we subtract 3h 44′½ the Residue 6h will be the time of the Stars Occultation; and if from the said time of Culmination we take away 2h 40′½, it leaves 7h 04′½ the true time of the Stars Emersion from the Moon.

To γ, the place of the Vertex at the time of the Stars Occultation, let ∗γ be drawn, and through the Moons Center ι ε Parallel to it; ιγ shall be the distance of the Star from the lowest Point of the Moons Periphery at the time of its Occultation, equal to ιγ in the Thirteenth Figure; and if in like manner we draw ∗δ from the Center of the Projection to the place of the Vertex at the Stars Emersion from the Moon, and through her Center ζθ Parallel to it, then will ζδ be the distance of the Star from the lowest Point of the Moons Periphery at its Emersion, equal to ιδ in the Thirteenth Figure, in which these Appearances are represented in respect of the Vertical ηι passing by the Moons Center.

If the Times of the Occultation and Emersion were required at some other place, whose Latitude and Difference of Meridians from *London* are known: First the Path of the Vertex must be drawn, then the hours numbred in the Line of the Moons way, if the place lie to the East of *London* must be accounted so much less if the Star be short of the Meridian, so much more if past it, as the difference of Meridians really is: But if the place lie to the West of *London*, then so much more whilst the Star is short of the Meridian, so much less when past, as is the said difference of Meridians.

And the time of the Occultation and Emersion of the Star, will be easily found by the Method before prescribed and employ'd.

Or the Difference of Meridians betwixt any two places whose Latitudes are known, may be investigated by the observed Occultation or Emersion of the Star from the Moons Limb, or its distances and Positions from her at both places, the times being carefully noted, by the Method suggested before in the description of the Solar Eclipse; nor is it necessary that the observed times of the same Appearance at both places should be known; For if the time of the Stars Occultation or Emersion at one place were accurately observed, at the other a distance and Position of the Star, the difference of Meridians may thence be determin'd as easily as if the Occultation and Emersion were observed at both places, by the Method suggested in the description of the Solar Eclipse.

And had we such Lunar Numbers as would shew us the Moons true place to half a Minute, or the 120th part of a Degree, we needed not doubt but that by this Method the Difference of Meridians betwixt the place to which the said Numbers should be fitted, and any other, where some Appearance of an *Appulse of the Moon* to any known fixed Star should be observed, might be readily obteined by one onely accurate observation; For the places of the fixed Stars I have hopes may be rectified to that exactness; The Work, by His *MAJESTIES Princely Care for the Improvement of NAVIGATION*, being somewhile since begun and carried on as far as the

the *Time* and the *Observers Accommodations* would permit; Nor is it to be feared, but that the Motions of the Moon may be rectified to as great exactness by the means of those many Lunar Observations, which have been frequently made at the *Observatory* by the same Person, and by others elsewhere, to far greater exactness than could formerly be hoped for, and that without omitting any opportunity when the season permitted, except when the Observers have been prevented by infirmities or indispensable occasions.

I have Numbred above 200 Fixed Stars in *Tycho*'s Catalogue that lie in the Moons way, and may all of them be Eclipsed by her in one Revolution of her Node; *The* Greenwich *Observations* make above 300: There can scarce happen 2 Nights together, but some or other of them will be Eclipsed in one place or other of the Earth. These Appulses seem therefore one of the best expedients that can be propounded for the discovery of the LONGITUDE, and surely since we have found and Taught so easy a way to Construct them, and that too perfectly *Geometrical*, those who are so urgent upon the *Astronomer* for a good Method to find it, will not think much to be at the pains to Learn and Understand this, seeing it may be practis'd by one Observer if accommodated with convenient Instruments; And I hope also that those Ingenious Persons who have imploy'd their pains and Studies to correct the *Old*, or find a *better Theory of the Moons Motions*, will be hereby encouraged to prosecute their useful Endeavours, considering both the facility of this Method, the Benefit is thence like to accrue to *Mankind*, and the *Reputation and Credit to themselves and their Memories*.

SECTION VIII.

HAving shewn in the preceding *Sections* how to find the places on the Earth, and Times there, where any of the principal Phases of a Solar Eclipse shall appear, by Calculation; as also how the Times of any Appearance of a Solar Eclipse or Stellar may be determin'd in any given Latitude and Longitude by Construction; It remains now, that I shew how the Times of the Principal Appearances and quantity of any Lunar Eclipse may also be found.

In the Fourth *Section* of this part I have taught how to find the Mean Time of the Mean opposition of the Luminaries, the Apparent Time of the True, their places then, and hourly Motions, their Horizontal Parallaxes and Semidiameters, with the nearest distance of the Moons Center from the Center of the Disk, and shadow, in her passage over either; I shall not need here therefore to repeat the directions how to find them; admit them known, and then,

Add the Moons Horizontal Parallax and the Suns (which I suppose always 10') together, from which Sum subtract the Suns Semidiameter, the remainer shall be the Semidiameter of the Earths shadow.

Add

Add the Moons Semidiameter to the Semidiameter of the ſhadow, if the Sum be greater than the neareſt diſtance of the Moons Center from the Center of the ſhadow at the time of the oppoſition in the Orbit, ſhe will be really Eclipſed, otherways not.

Subtract the Moon's Semidiameter from the Semidiameter of the ſhadow, ſo have you their difference, which if it be greater than the ſaid neareſt diſtance of the Moons Center from the ſhadows, the Eclipſe will be Total, otherways only partial.

From the Sum of the Semidiameters of the Moon and ſhadow ſubtract the neareſt diſtance of their Centers, the Reſidue is the parts deficient:

Say Then,

As the Moons Semidiameter,
To 6 Digits;
So are the parts deficient,
To the Digits Eclipſed.

Again,

As the Sum of the Semidiameters of the Moon and ſhadow,
To the Radius;
So the neareſt diſtance of the Centers of the ☽ and ſhadow at the ☍ in the Orbit,
To the Co-ſine of the Angle of Incidence.

And in Total Eclipſes,

As the difference of the Semidiameters of the Moon and ſhadow,
To the Radius;
So the ſaid neareſt diſtance of their Centers,
To the Co-ſine of the Angle of Immerſion, or Emerſion.

H

For the Motion of Semiduration,

As the Radius,
To the Sine of the Angle of Incidence;
So the Sum of the Semidiameters of the Moon and ſhadow,
To the ſaid Motion of Semiduration.

And in Total Eclipſes,

As the Radius,
To the Sine of the Angle of Immerſion;
So the difference of the Semidiameters of the Moon and ſhadow,
To the Motion of Semimora, or half Continuance of the Total Darkneſs.

To convert which Motions into Time, say again,

As the hourly Motion of the Moon from the Earth,
To one hour, or 60 Minutes;
So the Motion of Semidiuration,
To half the time of the whole continuance of the Eclipse.

And,

So the Motion of Semimora,
To half the time of the continuance of Total Darkness.

The half time of whole continuance subtracted from and added to the Apparent time of the middle of the Eclipse, gives the true time of its Beginning and End, and in like manner,

Half the time of the continuance in Total Darkness subtracted from and added to the Time of the middle gives the true Times of the Immersion and Emersion, or beginning and end of Total Darkness.

To illustrate these precepts by an Example, I shall give the heads of the Calculus of a partial Lunar Eclipse, which will happen in *August*, 1681.

The Mean time of the Mean opposition is on the 18th. Day *Old-Stile*, at 9h 47′ 37″ p. m.

		°	′	″
The Earths Mean Anomaly then		02	00	48 41
The Suns true place	♒	06	01	30
The Annual Argument		08	06	09 30
The Moons Mean Anomaly		01	28	02 40
Her true place in her Orbit	♓	03	19	36
Short of the opposition		00	02	41 54

	h	′	″
The Earths true hourly Motion 2′25″, Moons		31	56
Hourly Motion of the Moon from the Earth		29	31
The Interval of the Mean and true ☌ add	05	29	06
The equal time of the true ☌ *Aug.* 18th. at	15	16	44 p. m.

At which Time,

	°	′	″
The Mean Anomaly of the Earth is	02	01	02 12
The Suns true place	♊ 06	14	48
The Annual Argument	08	06	21 16
The Moons Mean Anomaly	11	10	51 26
Her true place in her Orbit	♓ 06	14	48
Her true hourly Motion 32′ 01″, from the Earth	00	00	29 36

Argument of Latitude	05	24	13 04

	°	′	″
Time of Reduction	00	03	04
Mean Time of the ☌ in the Ecliptick	15	13	40
Mean time of the middle of Eclipſe	15	19	48

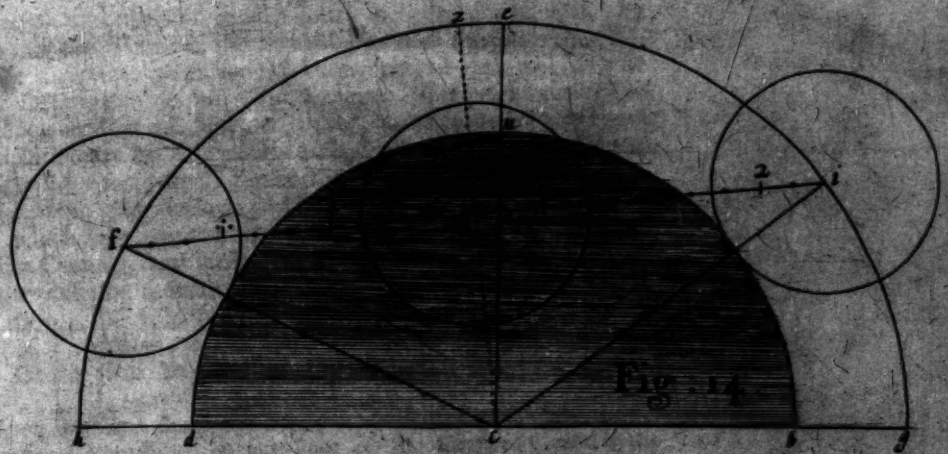
Equation of Days ſubtract from the Mean time	00	00	28
Apparent time of the middle of the Eclipſe	15	19	20

	°	′	″
Moons Horizontal Parallax	00	56	47
Suns Semidiameter ſubtracted	00	15	58
Semidiameter of the ſhadow	00	40	49
Moons Semidiameter	00	15	25
Their Sum	00	56	14
The Moons Latitude North ſubtract	00	30	12
The parts deficient	00	26	02
Digits Eclipſed 10 Digits 8′.			
Angle of Incidence	57	31	00
Motion of Semiduration	00	47	26

	°	′	″
Time of Semiduration	01	36	09

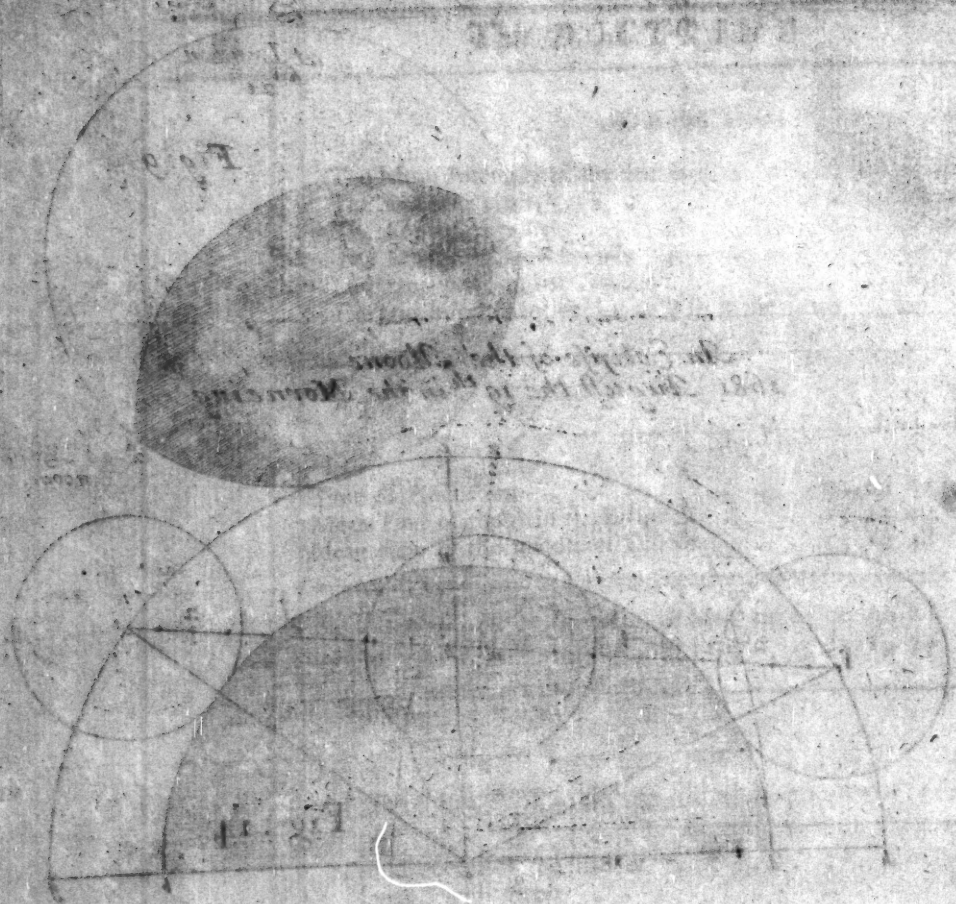
There

An Eclipse of the Moone
1681 August the 19th in the Morneing



A Scale of Minutes.

between page 72 and 73. the Doctrine of the Sphere.



Therefore,

The beginning of the Eclipse at	1	43	11	After the Midnight following the Eighteenth of *August*, at the right Day in the Morning.
Ecliptical ☍ of the Planets	2	14	12	
Middle or greatest Obscuration	3	19	20	
End	4	55	26	
Total duration	3	12	18	

The Times of any Appearance of a Lunar Eclipse may be found by Construction, as the Times of the general Phases of the Solar were before; and the directions given for the Protraction of that will likewise serve for the Delineation of this. For Example, if it were required to represent *in Plano* the Lunar Eclipse, of which I have now found the Times of the principal Phases by Calculation; Having made a Scale of Minutes, or equal parts for your purpose, take thence the Sun of the Semidiameters of the Moon and Shadow, 35′ 42″ and drawing first a streight Line *h c g*, which may represent an Arch of the Ecliptick, upon Paper; chuse therein a Center *c*, and setting one Foot of the Compasses thereon, with the other describe a Semicircle *h n g* (if the Moon have North Latitude) above, if South, beneath the Line; but if her Latitude be nor more than 5 Minutes, an entire Circle, in the Periphery of this the Moons Center shall be found at the Beginning and End of the Eclipse.

Taking from the Line Scale the Semidiameter of the shadow 40 $\frac{22}{60}$ betwixt your Compasses, set one Foot on the Center *c*, and with the other describe the Semicircle *d n b*, this shall represent half the shadow.

From *c* raise the Line *c z* Perpendicular to the Ecliptick *d g*, and then making *c c*, the Radius of a Line of Chords, take the Chord of 89° 41′ (the Angle which the Perpendicular to the Moons way makes with the Ecliptick) and setting it off from *c* to *z*, draw the Line *z c*, this shall be the said Perpendicular.

From the Scale of Minutes take 30′ $\frac{22}{60}$ betwixt your Compasses, and transfer them in the Line *c z*, from *c* to *m*, through *m* draw the Line *i m f* at Right angles to *z c*, this shall be the Line of the Moons way, and the Points *i*, *m*, and *f*, the places of her Center at the Beginning, Middle, and End of the Eclipse.

From the Center *c* draw the Lines *c i* and *c f*, the Angle *m c i* = *m c f* formed hereby shall be the Angle of Incidence.

The middle of the Eclipse happens 19′ 20″ after 3 in the Morning, the Moons horary Motion from the Earth is 29′ 36″; therefore in 19′ 20″, her Motion from the Earth 09′ 32″; take therefore 09′ $\frac{32}{60}$ from the Scale of Minutes betwixt your Compasses, and setting one Foot on *m*, with the other make a mark on the Line of the Moons way on the Left-hand, this shall be the place of the Moons Center at 3 hours after Midnight, or in the Morning.

Taking from the same Scale 29′ $\frac{36}{60}$ the Moons hourly Motion from the Earth, set it off in the said Line from 3. on both sides, it gives you the Points 2 and 4, or the place of the Moons Center at 2 and 4 a Clock in the Morning.

And if the spaces betwixt these be divided into 60 parts, and the Residue of the Line till it touch the utmost Circle, in the same manner, the Minutes there shall shew the Beginning and End of the Eclipse.

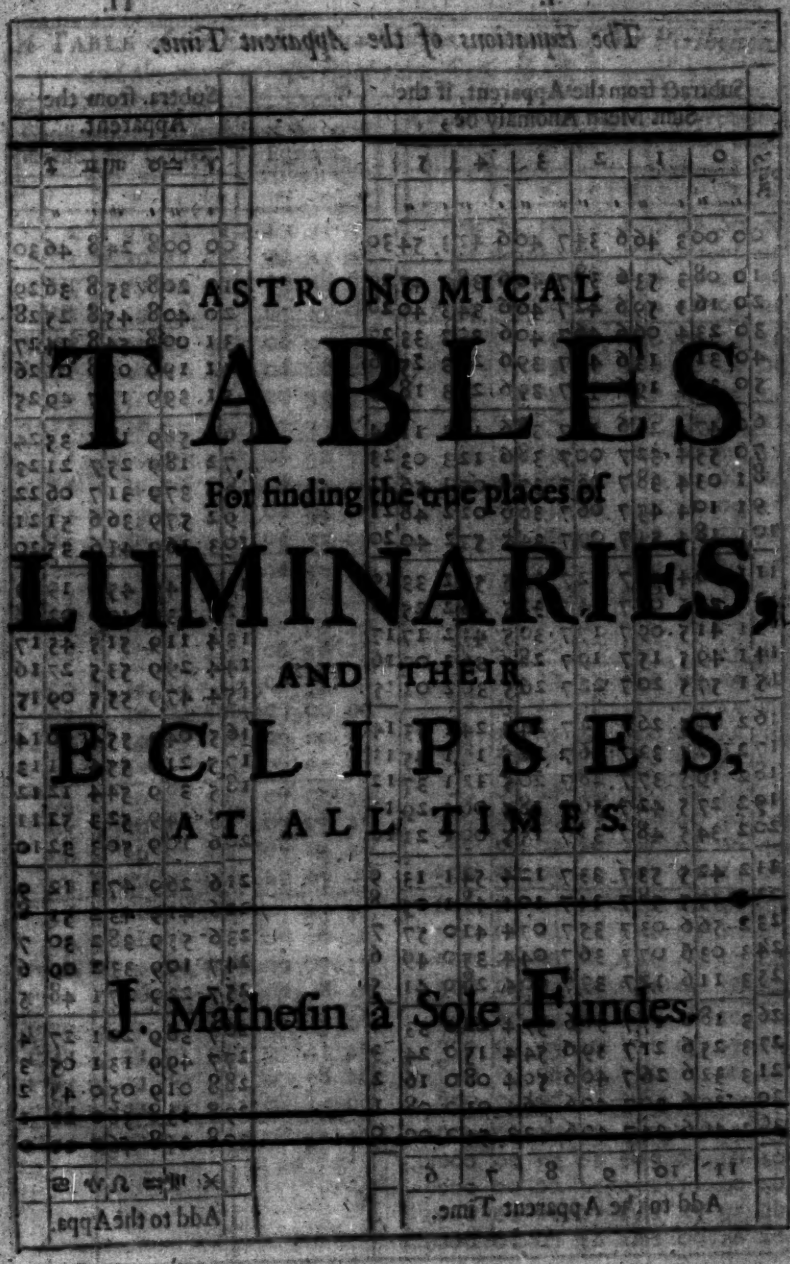
In the Figure I have divided the Line of the Moons way only to every 10 Minutes, it being sufficient for the Explication of the Method, which I esteem far more troublesome than a Calculation, and therefore should rather perswade the use of the Pen, than the Compasses to determin the Appearances of Lunar Eclipses.

In the Calculation of which, as also of the Principal Phases of the Solar, I must frequently *Note*, that tho I have employ'd the Line of the Moons way, and that which connects her Center with the Center of the Disk, or Shadow, at their nearest distance, as if they were perfect streight Lines; yet are they really small Arches of great Circles, whose Curvities are so little, that their difference from streight Lines is imperceptible, and the Error, that is caused by my using them as such, altogether inconsiderable.

The difference of Meridians betwixt any two places on the Earths Globe, may be readily obtained by the observation of the same Appearance of a Lunar Eclipse, or the Occultation or Emersion of the same Spot from the Earths shadow accurately noted at both places, for the difference of the observed Times shall be the difference of Meridians betwixt those two places *in Time*, of which that shall be to the East from the other, where the Noted time is the most from Noon: For Example in the Year 1678, *October* the 19th. *Old-Stile*, the end of a Lunar Eclipse was accurately Noted at His *MAJESTIES Observatory* at *Greenwich* at 10ʰ 10′ 38″ Afternoon; but at *Paris* at 10ʰ 20′; wherefore the difference of Meridians betwixt the *Observatories* of *Greenwich* and *Paris* by this Observation should be 9′ 22″ of Time. We observed likewise in the same Eclipse that the *Spot* called *Dysmarium* by *Hevelius* was first covered by the shadow at *Greenwich* at 7ʰ 09′ 14″, but at *Paris* its Occultation was Noted at 7ʰ 18′ 28″, whence the difference is found onely 9′ 14″, or 2″ 18‴, and so much we have determin'd the difference of Meridians betwixt the *Observatories* of *Paris* and *Greenwich*, by comparing 22 several Appearances carefully observed in the same Eclipse at both places.

As by Lunar Eclipſes, ſo alſo by the Eclipſes of *Jupiters* Satellits, the difference of the obſerved Moments of the Occultation or Emerſion of a Satellit from his ſhadow noted carefully in two diſtant places will be the difference of Meridians betwixt thoſe two places in Time; But I cannot hope that this Method ſhall prove of much uſe to the Ingenuous *Sea-men*, becauſe the Obſervations require long Teleſcopes which in a Ship will hardly be manageable. Nor can we expect to find the difference of Meridians by one only Obſervation of a Satellit Eclipſe, as we have hopes we may by a Lunar, by reaſon that as yet the inequalities in their Motions, and the time required for the Tranſmiſſion of Light from the Planet to our Earth are unknown; Nay their Mean Motions are ſcarce ſo exactly ſtated, but that we may juſtly ſuſpect them erroneous; Omitting theſe therefore, the beſt Method for the diſcovery of the *Longitude* will be in my opinion by the Moons *Appulſes* to, or *obſerved diſtances* from fixed Stars, upon which account I would recommend the Improvement and Correction of her *Theory*, with the *Doctrine* and *Conſtruction of Appulſes*, to the Study of the Ingenuous Aſtronomer and Sea-men.

As by Lunar Eclipses, so also by the Eclipses of Jupiters Satellits, the difference of the observed Moments of the Occultation or Emertion of a Satellit from his Shadow noted carefully in two distant places will be the difference of Meridians between those two places in Time. But I cannot hope that this Method shall prove of much use to the Ingenuous Sea-man, because the Observations require long Telescopes which in a Ship will hardly be manageable. Nor can we expect to find the difference of Meridians by one only Observation of a Satellit Eclipse, as we have hopes we may by a Lunar, by reason that as yet the inequalities in their Motions, and the time required for the Translation of Light from the Planet to our Earth are unknown; May their Mean Motions are hard to exactly ascertain, but that we may justly suspect them erroneous; Omitting therefore, the best Method for the discovery of the Longitude will be in my opinion by the Moons Appulses to, or observed distances from fixed Stars, upon which account I would recommend the Improvement and Correction of her Theory, with the Tables and Canon thereof, Appulses to the Study of the Ingenuous Agronomer and Sea-man.



ASTRONOMICAL

TABLES

For finding the true places of

LUMINARIES,

AND THEIR

ECLIPSES,

AT ALL TIMES.

J. Mathesin à Sole Fundes.

I. II.

The Equations of the Apparent Time.

Sign.	Subtract from the Apparent, if the Sun's Mean Anomaly be, 0	1	2	3	4	5		Subtra. from the Apparent. ♈ ♎ ♑ ♋ ♐ ♓	
	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″		′ ″	
00	00 03	46 6	34 7	40 6	42 3	54 3	30	00 00 8	24 8 46 30
10	08 3	53 6	38 7	40 6	38 3	47 3	29	20 8	35 8 36 29
20	16 3	59 6	42 7	40 6	34 3	40 3	28	40 8	45 8 25 28
30	23 4	06 6	46 7	40 6	29 3	33 3	27	1 00 8	54 8 14 27
40	31 4	13 6	49 7	39 6	25 3	25 3	26	1 19 9	03 8 01 26
50	38 4	19 6	52 7	39 6	21 3	18 3	25	1 39 9	11 7 49 25
60	47 4	26 6	55 7	38 6	16 3	11 3	24	1 59 9	18 7 35 24
70	55 4	32 7	00 7	38 6	12 3	03 3	23	2 18 9	25 7 21 23
81	03 4	38 7	03 7	37 6	07 3	56 3	22	2 37 9	31 7 06 22
91	10 4	45 7	06 7	36 6	02 3	48 3	21	2 57 9	36 6 51 21
101	18 4	51 7	09 7	34 5	57 3	40 3	20	3 16 9	41 6 35 20
11	26 4	57 7	12 7	33 5	52 3	33 3	19	3 35 9	45 6 19 19
12	34 5	03 7	14 7	32 5	47 3	25 3	18	3 54 9	48 6 02 18
131	41 5	09 7	17 7	30 5	41 3	17 3	17	4 13 9	51 5 45 17
141	49 5	15 7	19 7	28 5	36 3	09 3	16	4 32 9	53 5 27 16
151	57 5	20 7	22 7	26 5	30 3	01 3	15	4 51 9	55 5 09 15
162	05 5	26 7	24 7	25 5	24 2	53 3	14	5 10 9	55 4 50 14
172	13 5	32 7	26 7	23 5	18 2	45 3	13	5 29 9	55 4 31 13
182	19 5	37 7	28 7	20 5	12 2	37 3	12	5 48 9	54 4 12 12
192	27 5	42 7	30 7	18 5	06 2	29 3	11	6 7 9	52 3 52 11
202	34 5	48 7	31 7	15 5	00 2	21 3	10	6 26 9	50 3 32 10
212	42 5	53 7	33 7	12 4	54 2	13 3	9	6 45 9	47 3 12 9
222	49 5	58 7	34 7	10 4	48 2	05 3	8	7 4 9	43 2 51 8
232	56 6	03 7	35 7	07 4	41 1	57 2	7	7 23 9	38 2 30 7
243	03 6	07 7	36 7	04 4	35 1	49 2	6	7 42 9	33 2 09 6
253	11 6	12 7	37 7	00 4	28 1	41 2	5	8 01 9	27 1 48 5
263	18 6	17 7	38 6	57 4	22 1	33 2	4	8 20 9	20 1 27 4
273	25 6	21 7	39 6	54 4	15 1	24 2	3	8 39 9	13 1 05 3
283	32 6	26 7	40 6	50 4	08 1	16 2	2	8 58 9	05 0 43 2
293	39 6	30 7	40 6	46 4	01 1	08 2	1	9 17 8	57 0 22 1
303	46 6	34 7	40 6	42 3	54 1	00 2	0	9 36 8	48 0 00 0
	11	10	9	8	7	6		♌ ♍ ♒ ♊ ♉ ♑	
	Add to the Apparent Time.							Add to the Appa.	

A TABLE *of the Earths Mean Motions, the place of her Perihelion, and the recess of the Equinoxes from the first ♈ of ♈.*

Years of Christ current.	Mean Motion of the Earth from the Equinox.				The ☉ Perihel. from the vernal Equinox.			
	♈	°	′	″	♈	°	′	″
1	0	07	55	50	2	13	21	40
1501	0	19	13	29	3	04	21	40
1581	0	19	49	58	3	05	28	20
1601	0	19	58	40	3	05	45	00
1621	0	20	07	42	3	06	01	40
1641	0	20	16	44	3	06	18	20
1661	0	20	25	46	3	06	35	00
1681	0	20	34	48	3	06	51	40
82	0	20	20	58	3	06	52	30
83	0	20	06	08	3	06	53	20
84	0	19	51	48	3	06	54	10
85	0	20	36	26	3	06	55	00
86	0	20	20	16	3	06	55	50
87	0	20	05	56	3	06	56	40
88	0	19	53	36	3	06	57	30
89	0	20	38	25	3	06	58	20
90	0	20	24	05	3	06	59	10
91	0	20	09	45	3	07	00	00
92	0	19	58	25	3	07	00	50
93	0	20	39	13	3	07	01	40
94	0	20	25	53	3	07	02	30
95	0	20	11	33	3	07	03	20
96	0	19	57	13	3	07	04	10
97	0	20	42	02	3	07	05	00
98	0	20	27	42	3	07	05	50
99	0	20	13	22	3	07	06	40
1700	0	19	59	02	3	07	07	30
1701	0	20	43	50	3	07	08	20
1721	0	20	52	52	3	07	25	02
1741	0	21	01	54	3	07	41	40
1761	0	21	10	56	3	07	58	20
1781	0	21	19	58	3	08	15	00
1801	0	21	29	01	3	08	31	40

Common Years.	Mean Motion for Compleat Years and first 3qurs.				The Perihelion			
	♈	°	′	″	♈	°	′	″
1	11	29	48	40	0	00	00	50
2	11	29	31	20	0	00	01	40
3	11	29	17	00	0	00	02	30
4	00	00	01	48	0	00	03	20
5	11	29	47	28	0	00	04	10
6	11	29	31	08	0	00	05	00
7	11	29	16	48	0	00	05	50
8	00	00	01	36	0	00	06	40
9	11	29	46	16	0	00	07	30
10	11	29	30	56	0	00	08	20
11	11	29	15	36	0	00	09	10
12	00	00	01	25	0	00	10	00
13	11	29	45	05	0	00	10	50
14	11	29	29	45	0	00	11	40
15	11	29	14	25	0	00	12	30
16	00	00	01	13	0	00	13	20
17	11	29	44	53	0	00	14	10
18	11	29	28	33	0	00	15	00
19	11	29	13	13	0	00	15	50
20	00	00	00	02	0	00	16	40
40	00	00	00	04	0	00	33	20
60	00	00	00	06	0	00	50	00
80	00	00	00	08	0	01	06	40
100	00	00	00	10	0	01	23	20
200	00	00	00	21	0	02	46	40
300	00	00	00	31	0	04	10	00
400	00	00	00	42	0	05	33	20
500	00	00	00	52	0	06	56	40
600	00	00	01	03	0	08	20	00
700	00	00	01	13	0	09	43	20
800	00	00	01	24	0	11	06	40
900	00	00	01	34	0	12	29	00
1000	00	00	01	45	0	13	53	20
2000	00	00	03	30	0	27	46	40
3000	00	00	05	15	1	11	40	00
4000	00	00	07	01	1	25	33	20
5000	00	00	08	46	1	09	26	40

A TABLE of the Earths Mean Motions

Days	January. Earths Mean Motion.				M P.	February. Earths Mean Motion.				M P.	March. Earths Mean Motion.				M P.	April. Earths Mean Motion.				M P.
	S	°	′	″	″	S	°	′	″	″	S	°	′	″	″	S	°	′	″	″
1	0	00	59	08	00	1	01	32	27	04	1	29	08	20	08	3	29	41	38	12
2	0	01	58	17	00	1	02	31	35	05	2	00	07	28	08	4	00	40	46	13
3	0	02	57	25	00	1	03	30	43	05	2	01	06	36	08	3	01	39	55	13
4	0	03	56	33	01	1	04	29	52	05	2	02	05	45	09	3	02	39	03	13
5	0	04	55	42	01	1	05	29	00	05	2	03	04	53	09	3	03	38	11	13
6	0	05	54	50	01	1	06	28	08	05	2	04	03	01	09	3	04	37	20	13
7	0	06	53	58	01	1	07	27	16	05	2	05	03	10	09	3	05	36	27	13
8	0	07	53	07	01	1	08	26	25	05	2	06	02	18	09	3	06	35	36	13
9	0	08	52	15	01	1	09	25	33	06	2	07	01	26	09	3	07	34	45	13
10	0	09	51	23	01	1	10	24	41	06	2	08	00	35	09	3	08	33	53	14
11	0	10	50	32	02	1	11	23	50	06	2	08	59	43	10	3	09	33	01	14
12	0	11	49	40	02	1	12	22	58	06	2	09	58	51	10	3	10	32	10	14
13	0	12	48	48	02	1	13	22	06	06	2	10	58	00	10	3	11	31	18	14
14	0	13	47	57	02	1	14	21	15	06	2	11	57	08	10	3	12	30	26	14
15	0	14	47	05	02	1	15	20	23	06	2	12	56	16	10	3	13	29	34	14
16	0	15	46	13	02	1	16	19	31	05	2	13	55	25	0	3	14	28	43	14
17	0	16	45	22	02	1	17	18	40	07	2	14	54	33	10	3	15	27	51	15
18	0	17	44	30	02	1	18	17	48	07	2	15	53	41	11	3	16	27	00	15
19	0	18	43	38	03	1	19	16	56	07	2	16	52	50	11	3	17	26	08	15
20	0	19	42	47	03	1	20	16	04	07	2	17	51	58	11	3	18	25	16	15
21	0	20	41	55	04	1	21	15	13	07	2	18	51	06	11	3	19	24	24	15
22	0	21	41	03	04	1	22	14	21	07	2	19	50	15	11	3	20	23	33	15
23	0	22	40	12	04	1	23	13	30	07	2	20	49	23	11	3	21	22	41	15
24	0	23	39	20	04	1	24	12	38	08	2	21	48	31	11	3	22	21	49	16
25	0	24	38	28	04	1	25	11	46	08	2	22	47	40	11	3	23	20	58	16
26	0	25	37	37	04	1	26	10	55	08	2	23	46	48	12	3	24	20	06	16
27	0	26	36	45	04	1	27	10	03	08	2	24	45	56	12	3	25	19	14	16
28	0	27	35	53	04	1	28	09	11	08	2	25	45	05	12	3	26	18	23	16
29	0	28	35	02	04						2	26	44	13	12	3	27	17	31	16
30	0	29	34	10	04						2	27	43	21	12	3	28	16	35	16
31	1	00	33	18	04						2	28	42	30	12					

to every Day in the Year.

Days	May. Earths Mean Motion.	M P.	June. Earths Mean Motion.	M P.	July. Earths Mean Motion.	M P.	August. Earths Mean Motion.	M P.
	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
1	3 29 15 48	17	4 29 49 06	21	5 29 23 16	25	6 29 56 34	29
2	4 00 14 56	17	5 00 48 14	21	6 00 22 24	25	7 00 55 42	29
3	4 01 14 04	17	5 01 47 23	21	6 01 21 32	25	7 01 54 51	29
4	4 02 13 13	17	5 02 46 31	21	6 02 20 40	25	7 02 53 59	30
5	4 03 12 21	17	5 03 45 39	21	6 03 19 49	25	7 03 53 07	30
6	4 04 11 29	17	5 04 44 48	21	6 04 18 57	26	7 04 52 16	30
7	4 05 10 38	17	5 05 43 56	22	6 05 18 06	26	7 05 51 24	30
8	4 06 09 46	17	5 06 43 04	22	6 06 17 14	26	7 06 50 32	30
9	4 07 08 54	18	5 07 42 13	22	6 07 16 22	26	7 07 49 41	30
10	4 08 08 03	18	5 08 41 21	22	6 08 15 31	26	7 08 48 49	30
11	4 09 07 11	18	5 09 40 29	22	6 09 14 39	26	7 09 47 57	31
12	4 10 06 19	18	5 10 39 38	22	6 10 13 47	26	7 10 47 06	31
13	4 11 05 28	18	5 11 38 46	22	6 11 12 56	27	7 11 46 14	31
14	4 12 04 36	18	5 12 37 54	23	6 12 12 04	27	7 12 45 22	31
15	4 13 03 44	18	5 13 37 03	23	6 13 11 12	27	7 13 44 31	31
16	4 14 02 53	19	5 14 36 11	23	6 14 10 21	27	7 14 43 39	31
17	4 15 02 01	19	5 15 35 19	23	6 15 09 29	27	7 15 42 47	31
18	4 16 01 09	19	5 16 34 28	23	6 16 08 37	27	7 16 41 56	31
19	4 17 00 18	19	5 17 33 36	23	6 17 07 46	27	7 17 41 04	32
20	4 17 59 26	19	5 18 32 44	23	6 18 06 54	28	7 18 40 12	32
21	4 18 58 34	19	5 19 31 53	24	6 19 06 02	28	7 19 39 21	32
22	4 19 57 42	19	5 20 31 01	24	6 20 05 11	28	7 20 38 29	32
23	4 20 56 51	20	5 21 30 09	24	6 21 04 19	28	7 21 37 37	32
24	4 21 55 59	20	5 22 29 18	24	6 22 03 27	28	7 22 36 46	32
25	4 22 55 07	20	5 23 28 26	24	6 23 02 36	28	7 23 35 54	32
26	4 23 54 16	20	5 24 27 34	24	6 24 01 44	29	7 24 35 02	33
27	4 24 53 24	20	5 25 26 43	24	6 25 00 52	28	7 25 34 11	33
28	4 25 52 33	20	5 26 25 51	24	6 26 00 01	29	7 26 33 19	33
29	4 26 51 41	20	5 27 24 59	25	6 26 59 09	29	7 27 32 27	33
30	4 27 50 49	21	5 28 24 08	25	6 27 58 17	29	7 28 31 36	33
31	4 28 49 58	21			6 28 57 26	29	7 29 30 44	33

A TABLE of the Earths Mean Motions

Days	Septemb. Earths Mean Motion.	M P.	Octob. Earths Mean Motion.	M P.	Novemb. Earths Mean Motion.	M P.	Decemb. Earths Mean Motion.	M P.
	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
1	8 00 29 52	33	9 00 04 02	38	10 00 37 20	42	11 00 11 30	46
2	8 01 29 01	34	9 01 03 10	38	10 01 36 29	42	11 01 10 38	46
3	8 02 28 09	34	9 02 02 19	38	10 02 35 37	42	11 02 09 47	46
4	8 03 27 17	34	9 03 01 27	38	10 03 34 45	42	11 03 08 55	46
5	8 04 26 26	34	9 04 00 35	38	10 04 33 54	42	11 04 08 03	46
6	8 05 25 34	34	9 04 59 44	38	10 05 33 02	42	11 05 07 12	47
7	8 06 24 42	34	9 05 58 52	38	10 06 32 10	43	11 06 06 20	47
8	8 07 23 51	34	9 06 58 00	38	10 07 31 19	43	11 07 05 28	47
9	8 08 22 59	35	9 07 57 08	39	10 08 30 27	43	11 08 04 37	47
10	8 09 22 07	35	9 08 56 17	39	10 09 29 35	43	11 09 03 45	47
11	8 10 21 16	35	9 09 55 25	39	10 10 28 44	43	11 10 02 53	47
12	8 11 20 24	35	9 10 54 34	39	10 11 27 52	43	11 11 02 02	47
13	8 12 19 32	35	9 11 53 42	39	10 12 27 00	43	11 12 01 10	48
14	8 13 18 41	35	9 12 52 50	39	10 13 26 09	44	11 13 00 18	48
15	8 14 17 49	35	9 13 51 59	39	10 14 25 17	44	11 13 59 27	48
16	8 15 16 57	36	9 14 51 07	40	10 15 24 25	44	11 14 58 35	48
17	8 16 16 05	36	9 15 50 15	40	10 16 23 34	44	11 15 57 43	48
18	8 17 15 14	36	9 16 49 24	40	10 17 22 42	44	11 16 56 52	48
19	8 18 14 22	36	9 17 48 32	40	10 18 21 50	44	11 17 56 00	48
20	8 19 13 30	36	9 18 47 40	40	10 19 20 59	44	11 18 55 08	48
21	8 20 12 39	36	9 19 46 49	40	10 20 20 07	44	11 19 54 17	49
22	8 21 11 47	36	9 20 45 57	40	10 21 19 15	45	11 20 53 25	49
23	8 22 10 55	36	9 21 45 05	41	10 22 18 24	45	11 21 52 33	49
24	8 23 10 04	37	9 22 44 14	41	10 23 17 32	45	11 22 51 42	49
25	8 24 09 12	37	9 23 43 22	41	10 24 16 40	45	11 23 50 50	49
26	8 25 08 20	37	9 24 42 30	41	10 25 15 49	45	11 24 49 58	49
27	8 26 07 29	37	9 25 41 39	41	10 26 14 57	45	11 25 49 07	49
28	8 27 06 37	37	9 26 40 47	41	10 27 14 05	45	11 26 48 15	49
29	8 28 05 45	37	9 27 39 55	41	10 28 13 13	46	11 27 47 23	50
30	8 29 04 54	37	9 28 39 04	41	10 29 12 22	46	11 28 46 32	50
31			9 29 38 12	42			11 29 45 40	50

A TABLE of the Earths Mean Motions to Hours, and Parts of an Hour.

H.	°	′	″	H.	°	′	″
	′	″	‴		′	″	‴
″	″	‴	⁗	″	″	‴	⁗
0	0	00	00	30	11	13	55
1	0	02	28	31	11	16	28
2	0	04	56	32	11	18	51
3	0	07	24	33	11	21	19
4	0	09	51	34	11	23	47
5	0	12	19	35	11	26	14
6	0	14	47	36	11	28	42
7	0	17	15	37	11	31	10
8	0	19	43	38	11	33	38
9	0	22	11	39	11	36	06
10	0	24	38	40	11	38	34
11	0	27	06	41	11	41	02
12	0	29	34	42	11	43	29
13	0	32	02	43	11	45	57
14	0	34	30	44	11	48	25
15	0	36	58	45	11	50	53
16	0	39	25	46	11	53	21
17	0	41	53	47	11	55	49
18	0	44	21	48	11	58	16
19	0	46	49	49	12	00	44
20	0	49	17	50	12	03	12
21	0	51	45	51	12	05	40
22	0	54	13	52	12	08	08
23	0	56	40	53	12	10	36
24	0	59	08	54	12	13	03
25	1	01	36	55	12	15	31
26	1	04	04	56	12	17	59
27	1	06	32	57	12	20	27
28	1	09	00	58	12	22	55
29	1	11	27	59	12	25	23
30	1	13	55	60	12	27	50

In the Leap-year after *February* add a Day to the given time, and its Motion to the Motions Collected.

A TABLE of the Equations of the Earths Orbit.

Subtract.

	Sign. 0	1	2	3	4	5	
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	0 00 00	0 56 28	1 38 33	1 54 59	1 40 37	0 58 33	30
1	0 01 57	0 58 11	1 39 33	1 54 59	1 39 37	0 56 46	29
2	0 03 55	0 59 52	1 40 31	1 55 00	1 38 35	0 54 59	28
3	0 05 53	1 01 33	1 41 28	1 54 57	1 37 32	0 53 11	27
4	0 07 51	1 03 12	1 42 24	1 54 52	1 36 27	0 51 22	26
5	0 09 49	1 04 50	1 43 17	1 54 45	1 35 19	0 49 31	25
6	0 11 47	1 06 27	1 44 09	1 54 36	1 34 10	0 47 40	24
7	0 13 44	1 08 03	1 44 58	1 54 25	1 32 59	0 45 48	23
8	0 15 40	1 09 38	1 45 46	1 54 12	1 31 47	0 43 55	22
9	0 17 37	1 11 12	1 46 31	1 53 57	1 30 32	0 42 01	21
10	0 19 34	1 12 45	1 47 16	1 53 38	1 29 16	0 40 06	20
11	0 21 30	1 14 16	1 47 58	1 53 18	1 27 58	0 38 11	19
12	0 23 25	1 15 46	1 48 38	1 52 57	1 26 39	0 36 14	18
13	0 25 21	1 17 14	1 49 17	1 52 34	1 25 18	0 34 17	17
14	0 27 16	1 18 42	1 49 53	1 52 08	1 23 55	0 32 20	16
15	0 29 10	1 20 08	1 50 27	1 51 40	1 22 31	0 30 22	15
16	0 31 04	1 21 32	1 50 59	1 51 09	1 21 05	0 28 23	14
17	0 32 57	1 22 55	1 51 29	1 50 37	1 19 38	0 26 24	13
18	0 34 50	1 24 16	1 51 58	1 50 03	1 18 08	0 24 24	12
19	0 36 43	1 25 37	1 52 24	1 49 28	1 16 38	0 22 23	11
20	0 38 35	1 26 56	1 52 48	1 48 50	1 15 06	0 20 22	10
21	0 40 25	1 28 12	1 53 11	1 48 09	1 13 32	0 18 21	9
22	0 42 15	1 29 27	1 53 31	1 47 27	1 11 57	0 16 20	8
23	0 44 05	1 30 41	1 53 49	1 46 43	1 10 22	0 14 19	7
24	0 45 54	1 31 53	1 54 06	1 45 56	1 08 44	0 12 16	6
25	0 47 42	1 33 04	1 54 19	1 45 08	1 07 05	0 10 14	5
26	0 49 28	1 34 12	1 54 31	1 44 18	1 05 25	0 08 12	4
27	0 51 15	1 35 20	1 54 41	1 43 25	1 03 44	0 06 09	3
28	0 53 00	1 36 26	1 54 50	1 42 31	1 02 01	0 04 06	2
29	0 54 44	1 37 30	1 54 55	1 41 35	1 00 18	0 02 03	1
30	0 56 28	1 38 33	1 54 59	1 40 37	0 58 33	0 00 00	0
	Sign. 11	10	9	8	7	6	

Add.

A TABLE of the Mean Motions of the Moon, her Apoge and Node.

Years of Christ	Moons Motion from the vernal Equinox.				Motion of the Apoge from the Equinox.				Motion of the Node from the Equinox.			
	☽	°	′	″	☽	°	′	″	☽	°	′	″
1	04	02	30	22	09	12	11	51	08	28	33	10
1501	01	29	40	22	03	29	41	51	01	25	46	34
1581	07	23	55	18	04	15	01	51	10	08	25	40
1601	00	07	29	02	07	18	51	51	09	11	35	27
21	04	21	02	46	10	22	41	51	08	14	45	15
41	09	04	36	30	01	26	31	51	07	17	55	01
61	01	18	10	14	05	00	21	51	06	21	04	47
81	06	01	43	58	08	04	11	51	05	24	14	33
82	10	11	07	01	09	14	51	41	05	04	54	50
83	02	20	30	03	10	25	31	30	04	15	35	07
84	06	29	53	06	00	06	11	20	03	26	15	22
85	11	22	56	45	01	16	57	51	03	06	52	30
86	04	01	49	43	02	27	37	40	02	17	32	47
87	08	11	12	47	04	08	17	30	01	28	13	04
88	00	19	35	50	05	18	57	20	01	08	53	21
89	05	13	09	27	06	29	43	51	00	19	30	28
90	09	22	32	30	08	10	23	41	00	00	10	45
91	02	01	56	31	09	21	03	30	11	10	51	01
92	06	11	18	35	11	01	43	20	10	21	31	18
93	11	04	02	13	00	12	29	51	10	02	08	25
94	03	12	14	15	01	23	09	41	09	12	48	42
95	07	22	38	18	03	03	49	30	08	23	28	55
96	00	02	01	20	04	14	29	20	08	04	09	16
97	04	24	34	58	05	25	15	51	07	14	46	22
98	09	03	58	06	07	05	55	41	06	25	27	39
99	01	13	21	01	08	17	05	30	06	06	07	56
1700	05	22	44	05	09	27	15	20	05	16	47	13
1701	10	15	17	44	11	08	01	51	04	27	24	30
1721	02	28	51	26	02	11	51	51	04	00	34	08
1741	07	12	25	10	03	15	41	51	03	03	43	55
1761	11	25	58	54	08	19	31	51	02	06	53	41
1781	04	09	32	38	10	23	21	51	01	10	03	28
1801	08	23	06	22	02	27	11	51	00	13	13	14

Com. Years Comp	Moons Mean Motion.				Mean Motion of the Apoge.				Mean Motion of the Node.			
	☽	°	′	″	☽	°	′	″	☽	°	′	″
1	04	09	23	03	01	10	39	50	00	19	59	42
2	08	18	46	05	02	21	19	39	01	08	39	26
3	00	28	09	08	04	01	59	29	01	27	59	09
4	05	20	42	45	05	12	46	00	02	17	22	03
5	10	00	05	47	06	23	25	50	03	06	41	46
6	02	09	28	49	08	04	05	39	03	26	01	29
7	06	18	51	52	09	14	45	29	04	15	21	12
8	11	11	25	29	10	25	32	00	05	04	44	05
9	03	20	48	32	00	06	11	50	05	24	03	48
10	08	00	11	34	01	16	51	39	06	13	23	32
11	00	09	34	37	02	27	31	29	07	02	43	15
12	05	02	48	15	04	08	18	00	07	22	06	08
13	09	11	31	17	05	18	57	50	08	11	25	51
14	01	20	54	20	06	29	37	39	09	00	45	34
15	06	00	17	22	08	10	17	29	09	20	05	17
16	10	22	51	00	09	21	04	00	10	09	28	11
17	03	02	14	02	11	01	43	50	10	28	47	54
18	07	11	37	04	00	12	23	39	11	18	07	37
19	11	21	00	07	01	23	03	29	00	07	27	20
20	04	13	33	40	03	03	50	00	00	26	50	13
40	08	27	07	28	06	07	40	00	01	23	40	27
60	01	10	41	12	09	11	30	00	02	20	30	40
80	05	24	14	56	00	15	20	00	03	17	20	54
100	01	07	48	40	03	19	10	00	04	14	11	07
200	08	15	37	20	07	08	20	00	08	28	22	13
300	06	23	26	00	10	27	30	00	01	12	33	20
400	05	01	14	40	02	16	40	00	05	26	44	27
500	03	09	03	20	06	05	50	00	10	10	55	33
600	01	16	52	00	09	25	00	00	02	25	06	40
700	11	24	40	40	01	14	10	00	07	09	17	47
800	10	02	29	20	01	03	20	00	11	23	28	53
900	08	10	18	00	08	22	30	00	04	07	40	00
1000	06	18	06	40	00	11	40	00	08	21	51	07
2000	01	06	13	20	00	23	20	00	05	13	42	14
3000	07	24	20	00	01	05	00	00	02	05	33	21
4000	02	12	26	40	01	16	40	00	10	27	24	27
5000	09	00	33	20	01	28	20	00	07	19	15	34

A TABLE of the Mean Motions of the Moon,

January.

Days	Moons Mean Motion.				Apoge.			Node Retrogr.		
	s	°	′	″	°	′	″	°	′	″
1	0	9	13	10	35	0	6	41	0	3	11
2	0	0	26	21	10	0	13	22	0	6	21
3	0	1	9	31	45	0	20	3	0	9	32
4	0	1	22	42	20	0	26	44	0	12	43
5	0	2	5	52	55	0	33	25	0	15	53
6	0	2	19	3	30	0	40	6	0	19	4
7	0	3	2	14	5	0	46	48	0	22	14
8	0	3	15	24	40	0	53	29	0	25	25
9	0	3	28	35	15	1	0	10	0	28	36
10	0	4	11	45	50	1	6	51	0	31	46
11	0	4	24	56	25	1	13	32	0	34	57
12	0	5	8	7	0	1	20	13	0	38	8
13	0	5	21	17	35	1	26	54	0	41	18
14	0	6	4	28	10	1	33	35	0	44	29
15	0	6	17	38	45	1	40	16	0	47	40
16	0	7	0	49	20	1	46	57	0	50	50
17	0	7	13	59	55	1	53	38	0	54	01
18	0	7	27	10	30	2	0	19	0	57	11
19	0	8	10	21	05	2	7	0	1	0	22
20	0	8	23	31	40	2	13	41	1	3	33
21	0	9	6	42	15	2	20	28	1	6	43
22	0	9	19	52	50	2	27	04	1	9	54
23	0	10	3	3	25	2	33	45	1	13	05
24	0	10	16	14	00	2	40	26	1	16	15
25	0	10	29	24	35	2	47	07	1	19	26
26	0	11	12	35	10	2	53	48	1	22	37
27	0	11	25	45	45	3	0	29	1	25	47
28	0	0	8	56	20	3	7	10	1	28	58
29	0	0	22	6	55	3	13	51	1	32	09
30	0	1	5	17	31	3	20	32	1	35	19
31	0	1	18	28	06	3	27	13	1	38	30

February.

Days	Moons Mean Motion.				Apoge.			Node Retrogr.		
	s	°	′	″	°	′	″	°	′	″
1	0	2	01	38	41	3	33	54	1	41	40
2	0	2	14	49	16	3	40	35	1	44	50
3	0	2	27	59	51	3	47	16	1	48	01
4	0	3	11	10	26	3	53	57	1	51	12
5	0	3	24	21	01	4	0	38	1	54	23
6	0	4	07	31	36	4	7	19	1	57	33
7	0	4	20	42	11	4	14	0	2	0	44
8	0	5	03	52	46	4	20	41	2	3	54
9	0	5	17	3	21	4	27	22	2	7	06
10	0	6	0	13	56	4	34	4	2	10	16
11	0	6	13	24	31	4	40	45	2	13	27
12	0	6	26	35	06	4	47	26	2	16	47
13	0	7	9	45	41	4	54	7	2	19	08
14	0	7	22	56	15	5	0	48	2	22	58
15	0	8	06	6	50	5	7	29	2	26	09
16	0	8	19	17	26	5	14	10	2	29	20
17	0	9	02	28	01	5	20	51	2	32	30
18	0	9	15	38	36	5	27	32	2	35	41
19	0	9	28	49	11	5	34	13	2	38	52
20	0	10	11	59	46	5	40	54	2	42	02
21	0	10	25	10	21	5	47	36	2	45	13
22	0	11	08	20	56	5	54	17	2	48	23
23	0	11	21	31	31	6	00	58	2	51	34
24	0	0	04	42	06	6	07	39	2	54	45
25	0	0	17	52	41	6	14	20	2	57	55
26	0	1	01	03	16	6	21	01	3	01	06
27	0	1	14	13	51	6	27	42	3	04	16
28	0	1	27	24	26	6	34	23	3	07	27

her Apoge, and Node, to every Day in the Year.

March.

Day.	Moons Mean Motion. ☽	°	′	″	A. Apoge. ☽	°	′	″	Node Retrogr. ☽	°	′	″
1	02	10	35	01	06	41	04	03	10	38		
2	02	23	45	36	06	47	45	03	13	49		
3	03	06	56	12	06	54	26	03	16	59		
4	03	20	06	46	07	01	07	03	20	10		
5	04	03	17	21	07	07	48	03	23	20		
6	04	16	27	56	07	14	29	03	26	31		
7	04	29	38	31	07	21	11	03	29	42		
8	05	12	49	06	07	27	52	03	32	52		
9	05	25	59	41	07	34	33	03	36	03		
10	06	09	10	16	07	41	14	03	39	14		
11	06	22	20	51	07	47	55	03	42	25		
12	07	05	31	26	07	54	36	03	45	36		
13	07	18	42	01	08	01	17	03	48	46		
14	08	01	52	36	08	07	58	03	51	56		
15	08	15	03	11	08	14	39	03	55	07		
16	08	28	13	46	08	21	20	03	58	18		
17	09	11	24	21	08	28	01	04	01	28		
18	09	24	34	56	08	34	42	04	04	39		
19	10	07	45	31	08	41	23	04	07	49		
20	10	20	56	07	08	48	04	04	11	00		
21	11	04	06	42	08	54	45	04	14	11		
22	11	17	17	17	09	01	27	04	17	22		
23	12	00	27	52	09	08	08	04	20	32		
24	12	13	38	27	09	14	49	04	23	43		
25	12	26	49	02	09	21	30	04	26	53		
26	13	09	59	37	09	28	11	04	30	04		
27	13	23	10	12	09	34	52	04	33	15		
28	14	06	20	47	09	41	33	04	36	25		
29	14	19	31	22	09	48	14	04	39	36		
30	15	02	41	57	09	54	55	04	42	47		
31	15	15	52	32	10	01	36	04	45	58		

April.

Day.	Moons Mean Motion. ☽	°	′	″	A. Apoge. ☽	°	′	″	Node Retrogr. ☽	°	′	″
1	16	03	29	03	10	08	17	04	49	08		
2	16	16	13	42	10	14	58	04	52	19		
3	16	29	24	17	10	21	39	04	55	29		
4	17	12	34	52	10	28	20	04	58	40		
5	17	25	45	27	10	35	02	05	01	51		
6	18	08	56	02	10	41	43	05	05	01		
7	18	22	06	38	10	48	24	05	08	12		
8	19	05	17	12	10	55	05	05	11	22		
9	19	18	27	47	11	01	46	05	14	33		
10	19	27	38	22	11	08	27	05	17	44		
11	20	10	48	57	11	15	08	05	20	54		
12	20	23	59	32	11	21	49	05	24	05		
13	21	07	10	07	11	28	30	05	27	16		
14	21	20	20	42	11	35	11	05	30	26		
15	22	03	31	17	11	41	52	05	33	37		
16	22	16	41	52	11	48	33	05	36	48		
17	22	29	52	27	11	55	14	05	39	58		
18	23	13	03	02	12	01	55	05	43	09		
19	23	26	13	37	12	08	36	05	46	19		
20	24	09	24	12	12	15	18	05	49	30		
21	24	22	34	47	12	21	59	05	52	41		
22	25	05	45	22	12	28	40	05	55	52		
23	25	18	55	57	12	35	21	05	59	02		
24	26	02	06	37	12	42	02	06	02	13		
25	26	15	17	07	12	48	43	06	05	24		
26	26	28	27	42	12	55	24	06	08	34		
27	27	11	38	17	13	02	05	06	11	45		
28	27	24	48	52	13	08	46	06	14	56		
29	28	07	59	27	13	15	27	06	18	06		
30	28	21	10	03	13	22	08	06	21	17		

A TABLE of the Mean Motions of the Moon,

May.

Days.	Moons Mean Motion.				Apoge.			Node Retrogr.		
	☽	°	′	″	°	′	″	°	′	″
1	05	04	20	37	13	28	49	06	24	27
2	05	17	31	12	13	35	30	06	27	38
3	06	00	41	47	13	42	11	06	30	48
4	06	13	52	22	13	48	52	06	33	59
5	06	27	02	57	13	55	34	06	37	10
6	07	10	13	32	14	02	15	06	40	20
7	07	23	24	07	14	08	56	06	43	31
8	08	06	34	42	14	15	37	06	46	41
9	08	19	45	17	14	22	18	06	49	52
10	09	02	55	59	14	28	59	06	53	03
11	09	16	06	27	14	35	40	06	56	13
12	09	29	17	03	14	42	21	06	59	24
13	10	12	27	38	14	49	02	07	02	34
14	10	25	38	13	14	55	43	07	05	45
15	11	08	48	48	15	02	24	07	08	56
16	11	21	59	23	15	09	05	07	12	06
17	00	05	09	58	15	15	46	07	15	17
18	00	18	20	33	15	22	28	07	18	27
19	01	01	31	08	15	29	09	07	21	38
20	01	14	41	43	15	35	50	07	24	49
21	01	27	52	18	15	42	31	07	28	00
22	02	11	02	53	15	49	12	07	31	10
23	02	24	13	28	15	55	53	07	34	21
24	03	07	24	03	16	02	34	07	37	32
25	03	20	34	38	16	09	15	07	40	43
26	04	03	45	13	16	15	56	07	43	53
27	04	16	55	48	16	22	37	07	47	04
28	05	00	06	23	16	29	18	07	50	14
29	05	13	16	58	16	35	59	07	53	25
30	05	26	27	33	16	42	40	07	56	36
31	06	09	38	08	16	49	21	07	59	46

June.

Days.	Moons Mean Motion.				Apoge.			Node Retrogr.		
	☽	°	′	″	°	′	″	°	′	″
1	06	22	48	43	16	56	03	08	02	56
2	07	05	59	18	17	02	44	08	06	07
3	07	19	09	53	17	09	25	08	09	18
4	08	02	20	28	17	16	06	08	12	29
5	08	15	31	03	17	22	47	08	15	39
6	08	28	41	38	17	29	28	08	18	50
7	09	11	52	13	17	36	09	08	22	00
8	09	25	02	48	17	42	50	08	25	11
9	10	08	13	23	17	49	31	08	28	22
10	10	21	23	58	17	56	12	08	31	32
11	11	04	34	33	18	02	53	08	34	43
12	11	17	45	08	18	09	34	08	37	54
13	00	00	55	43	18	16	15	08	41	05
14	00	14	06	18	18	22	56	08	44	16
15	00	27	16	53	18	29	37	08	47	26
16	01	10	27	28	18	36	19	08	50	37
17	01	23	38	03	18	43	00	08	53	47
18	02	06	48	38	18	49	41	08	56	58
19	02	19	59	13	18	56	22	09	00	09
20	03	03	09	48	19	03	03	09	03	19
21	03	16	20	23	19	09	44	09	06	30
22	03	29	30	58	19	16	25	09	09	40
23	04	12	41	33	19	23	06	09	12	51
24	04	25	52	08	19	29	47	09	16	02
25	05	09	02	43	19	36	28	09	19	12
26	05	22	13	18	19	43	09	09	22	23
27	06	05	23	53	19	49	50	09	25	34
28	06	18	34	28	19	56	31	09	28	45
29	07	01	45	04	20	03	12	09	31	55
30	07	14	55	39	20	09	54	09	35	06

ber Apoge, and Node, to every Day in the Year.

July.

Days.	Moons Mean Motion.				Apoge.			Node Retrogr.		
	s.	o.	′	″	o.	′	″	o.	′	″
1	07	28	06	14	20	16	35	29	38	16
2	08	11	16	49	20	23	16	29	41	27
3	08	24	27	24	20	29	57	29	44	37
4	09	07	37	59	20	36	38	29	47	47
5	09	20	48	34	20	43	19	29	50	59
6	10	03	59	09	20	50	00	29	54	09
7	10	17	09	44	20	56	41	29	57	20
8	11	00	20	19	21	03	22	30	00	30
9	11	13	30	54	21	10	03	30	03	41
10	11	26	41	29	21	16	44	30	06	51
11	00	09	52	04	21	23	25	30	10	02
12	00	23	02	39	21	30	06	30	13	13
13	01	06	13	14	21	36	47	30	16	24
14	01	19	23	49	21	43	28	30	19	35
15	02	02	34	24	21	50	09	30	22	45
16	02	15	44	59	21	56	52	30	25	56
17	02	28	55	34	22	03	32	30	29	06
18	03	12	06	09	22	10	13	30	32	17
19	03	25	16	44	22	16	54	30	35	28
20	04	08	27	19	22	23	35	30	38	39
21	04	21	37	54	22	30	15	30	41	49
22	05	04	48	29	22	36	56	30	45	00
23	05	17	59	04	22	43	37	30	48	11
24	06	01	09	39	22	50	19	30	51	21
25	06	14	20	14	22	57	00	30	54	32
26	06	27	30	49	23	03	41	30	57	42
27	07	10	41	24	23	10	22	31	00	53
28	07	23	51	59	23	17	03	31	04	03
29	08	07	02	34	23	23	44	31	07	14
30	08	20	13	09	23	30	25	31	10	25
31	09	03	23	44	23	37	06	31	13	36

August.

Days.	Moons Mean Motion.				Apoge.			Node Retrogr.		
	s.	o.	′	″	o.	′	″	o.	′	″
1	09	16	34	19	23	43	47	31	16	47
2	09	29	44	54	23	50	28	31	19	58
3	10	12	55	29	23	57	09	31	23	08
4	10	26	06	04	24	03	51	31	26	19
5	11	09	16	39	24	10	32	31	29	29
6	11	22	27	14	24	17	13	31	32	40
7	00	05	37	49	24	23	54	31	35	51
8	00	18	48	24	24	30	35	31	39	02
9	01	01	58	59	24	37	16	31	42	12
10	01	15	09	34	24	43	57	31	45	23
11	01	28	20	09	24	50	38	31	48	33
12	02	11	30	44	24	57	19	31	51	44
13	02	24	41	19	25	04	00	31	54	54
14	03	07	51	54	25	10	42	31	58	05
15	03	21	02	29	25	17	23	32	01	15
16	04	04	13	04	25	24	04	32	04	26
17	04	17	23	40	25	30	45	32	07	36
18	05	00	34	15	25	37	26	32	10	47
19	05	13	44	50	25	44	07	32	13	58
20	05	26	55	25	25	50	48	32	17	08
21	06	10	06	00	25	57	29	32	20	19
22	06	23	16	35	26	04	10	32	23	29
23	07	06	27	10	26	10	51	32	26	40
24	07	19	37	45	26	17	32	32	29	51
25	08	02	48	20	26	24	13	32	33	01
26	08	15	58	55	26	30	55	32	36	12
27	08	29	09	30	26	37	36	32	39	23
28	09	12	20	05	26	44	17	32	42	34
29	09	25	30	40	26	50	58	32	45	44
30	10	08	41	15	26	57	39	32	48	55
31	10	21	51	50	27	04	20	32	52	05

A TABLE of the Mean Motions of the Moon,

September.

Days.	Moons Mean Motion.				Apoge.				Node Retrogr.			
	☽	°	′	″	☽	°	′	″	°	′	″	
1	11	05	02	25	0	27	11	01	12	55	16	
2	11	18	13	00	0	27	17	42	12	58	27	
3	00	01	23	35	0	27	24	23	13	01	37	
4	00	14	34	10	0	27	31	04	13	04	48	
5	00	27	44	45	0	27	37	45	13	07	58	
6	01	10	55	20	0	27	44	26	13	11	09	
7	01	24	05	55	0	27	51	07	13	14	20	
8	02	07	16	30	0	27	57	48	13	17	31	
9	02	20	27	05	0	28	04	29	13	20	41	
10	03	03	37	40	0	28	11	11	13	23	52	
11	03	16	48	15	0	28	17	52	13	27	03	
12	03	29	58	50	0	28	24	33	13	30	14	
13	04	13	09	25	0	28	31	14	13	33	24	
14	04	26	20	00	0	28	37	55	13	36	35	
15	05	09	30	35	0	28	44	36	13	39	45	
16	05	22	41	10	0	28	51	17	13	42	56	
17	06	05	51	45	0	28	57	58	13	46	07	
18	06	19	02	20	0	29	04	39	13	49	17	
19	07	02	12	55	0	29	11	20	13	52	28	
20	07	15	23	30	0	29	18	01	13	55	38	
21	07	28	34	05	0	29	24	42	13	58	49	
22	08	11	44	40	0	29	31	23	14	02	00	
23	08	24	55	15	0	29	38	04	14	05	10	
24	09	08	05	50	0	29	44	45	14	08	21	
25	09	21	16	25	0	29	51	27	14	11	31	
26	10	04	27	00	0	29	58	08	14	14	42	
27	10	17	37	35	1	00	04	49	14	17	53	
28	11	00	48	10	1	00	11	30	14	21	03	
29	11	13	58	45	1	00	18	11	14	24	14	
30	11	27	09	20	1	00	24	52	14	27	24	
31												

October.

Days.	Moons Mean Motion.				Apoge.				Node Retrogr.			
	☽	°	′	″	☽	°	′	″	°	′	″	
1	00	20	19	55	1	00	31	33	14	30	35	
2	00	23	30	30	1	00	38	14	14	33	46	
3	01	06	41	05	1	00	44	55	14	36	56	
4	01	19	51	40	1	00	51	36	14	40	07	
5	02	03	02	15	1	00	58	17	14	43	17	
6	02	16	12	50	1	01	04	58	14	46	28	
7	02	29	23	26	1	01	11	39	14	49	39	
8	03	12	34	01	1	01	18	20	14	52	50	
9	03	25	44	36	1	01	25	02	14	56	00	
10	04	08	55	11	1	01	31	43	14	59	11	
11	04	22	05	46	1	01	38	24	15	02	21	
12	05	05	16	21	1	01	45	05	15	05	32	
13	05	18	26	56	1	01	51	46	15	08	43	
14	06	01	37	31	1	01	58	27	15	11	53	
15	06	14	48	06	1	02	05	08	15	15	04	
16	06	27	58	41	1	02	11	49	15	18	15	
17	07	11	09	16	1	02	18	30	15	21	28	
18	07	24	19	51	1	02	25	11	15	24	36	
19	08	07	30	26	1	02	31	52	15	27	47	
20	08	20	41	01	1	02	38	33	15	30	57	
21	09	03	51	36	1	02	45	14	15	34	08	
22	09	17	02	11	1	02	51	55	15	37	19	
23	10	00	12	46	1	02	58	36	15	40	29	
24	10	13	23	21	1	03	05	17	15	43	40	
25	10	26	33	56	1	03	11	58	15	46	50	
26	11	09	44	31	1	03	18	39	15	50	01	
27	11	22	55	06	1	03	25	21	15	53	12	
28	00	06	05	41	1	03	32	02	15	56	22	
29	00	19	16	16	1	03	38	43	15	59	33	
30	01	02	26	51	1	03	45	24	16	02	43	
31	01	15	37	26	1	03	52	05	16	05	54	

her Apoge, and Node, to every Day in the Year.

November.

Days.	Moons Mean Motion.				Apoge.				Node Retrogr.		
	s	°	′	″	s	°	′	″	°	′	″
1	01	28	48	01	1	03	58	46	16	09	05
2	02	11	58	36	1	04	05	27	16	12	16
3	02	25	09	11	1	04	12	08	16	15	26
4	03	08	19	46	1	04	18	49	16	18	37
5	03	21	30	21	1	04	25	30	16	21	48
6	04	04	40	56	1	04	32	11	16	24	59
7	04	17	51	31	1	04	38	53	16	28	09
8	5	01	02	06	1	04	45	34	16	31	20
9	05	14	12	41	1	04	52	15	16	34	30
10	05	27	23	16	1	04	58	56	16	37	41
11	06	10	33	51	1	05	05	37	16	40	52
12	06	23	44	26	1	05	12	18	16	44	02
13	07	06	55	01	1	05	18	59	16	47	13
14	07	20	05	36	1	05	25	40	16	50	23
15	08	03	16	11	1	05	32	21	16	53	34
16	08	16	26	46	1	05	39	02	16	56	45
17	08	29	37	21	1	05	45	43	16	59	55
18	09	12	47	56	1	05	52	24	17	03	06
19	09	25	58	31	1	05	59	05	17	06	16
20	10	09	09	06	1	06	05	46	17	09	27
21	10	22	19	41	1	06	12	27	17	12	38
22	11	05	30	16	1	06	19	09	17	15	49
23	11	18	40	51	1	06	25	50	17	18	59
24	00	01	51	26	1	06	32	31	17	22	10
25	00	15	02	02	1	06	39	12	17	25	21
26	00	28	12	37	1	06	45	53	17	28	32
27	01	11	23	12	1	06	52	34	17	31	42
28	01	24	33	47	1	06	59	15	17	34	53
29	02	07	44	22	1	07	05	56	17	38	03
30	02	20	54	57	1	07	12	37	17	41	14

December.

Days.	Moons Mean Motion.				Apoge.				Node Retrogr.		
	s	°	′	″	s	°	′	″	°	′	″
1	03	04	05	32	1	07	19	18	17	44	25
2	03	17	16	07	1	07	25	59	17	47	35
3	04	00	26	42	1	07	32	40	17	50	46
4	04	13	37	17	1	07	39	21	17	53	56
5	04	26	47	52	1	07	46	02	17	57	07
6	05	09	58	27	1	07	52	43	18	00	18
7	05	23	09	02	1	07	59	24	18	03	28
8	06	06	19	37	1	08	06	06	18	06	39
9	06	19	30	12	1	08	12	47	18	09	49
10	07	02	40	47	1	08	19	28	18	13	00
11	07	15	51	22	1	08	26	09	18	16	11
12	07	29	01	57	1	08	32	50	18	19	21
13	08	12	12	32	1	08	39	31	18	22	32
14	08	25	23	07	1	08	46	12	18	25	42
15	09	08	33	42	1	08	52	53	18	28	53
16	09	21	44	17	1	08	59	34	18	32	04
17	10	04	54	52	1	09	06	15	18	35	15
18	10	18	05	27	1	09	12	56	18	38	25
19	11	01	16	02	1	09	19	38	18	41	36
20	11	14	26	37	1	09	26	19	18	44	47
21	11	27	37	12	1	09	33	00	18	47	58
22	00	10	47	47	1	09	39	41	18	51	09
23	00	23	58	22	1	09	46	22	18	54	19
24	01	07	08	57	1	09	53	03	18	57	30
25	01	20	19	32	1	09	59	44	19	00	41
26	02	03	30	07	1	10	06	25	19	03	51
27	02	16	40	42	1	10	13	06	19	07	02
28	02	29	51	17	1	10	19	47	19	10	12
29	03	13	01	52	1	10	26	28	19	13	23
30	03	26	12	27	1	10	33	09	19	16	34
31	04	09	23	02	1	10	39	50	19	19	45

A TABLE *of the Moons Mean Motions to Hours and Parts of an Hour.*

H.	°	′	″	′	″	′	″	H.	°	′	″	′	″	′	″
	′	″	‴	″	‴	″	‴		′	″	‴	″	‴	″	‴
0	0	00	00	0	00	0	00	30	16	28	14	8	21	3	58
1	0	32	56	0	17	0	08	31	17	01	10	8	38	4	06
2	1	05	53	0	33	0	16	32	17	34	07	8	54	4	14
3	1	38	49	0	50	0	24	33	18	07	03	9	11	4	22
4	2	11	46	1	07	0	32	34	18	39	59	9	28	4	30
5	2	44	42	1	24	0	40	35	19	12	55	9	45	4	38
6	3	17	39	1	40	0	48	36	19	45	52	10	02	4	46
7	3	50	35	1	57	0	56	37	20	18	48	10	19	4	54
8	4	23	32	2	14	1	04	38	20	51	45	10	36	5	02
9	4	56	28	2	30	1	12	39	21	24	41	10	52	5	10
10	5	29	25	2	47	1	19	40	21	57	38	11	08	5	18
11	6	02	21	3	04	1	27	41	22	30	34	11	25	5	26
12	6	35	18	3	21	1	35	42	23	03	31	11	42	5	34
13	7	08	14	3	37	1	43	43	23	36	27	11	59	5	42
14	7	41	10	3	54	1	51	44	24	09	24	12	16	5	50
15	8	14	07	4	11	1	59	45	24	42	20	12	32	5	58
16	8	47	03	4	27	2	07	46	25	15	17	12	48	6	06
17	9	20	00	4	44	2	15	47	25	48	13	13	05	6	14
18	9	52	56	5	01	2	23	48	26	21	10	13	22	6	22
19	10	25	53	5	18	2	31	49	26	54	06	13	39	6	30
20	10	58	49	5	34	2	39	50	27	27	03	13	56	6	38
21	11	31	46	5	51	2	47	51	27	59	59	14	13	6	46
22	12	04	42	6	08	2	55	52	28	32	56	14	30	6	54
23	12	37	39	6	24	3	03	53	29	05	52	14	46	7	01
24	13	10	35	6	41	3	11	54	29	38	49	15	02	7	08
25	13	43	32	6	58	3	19	55	30	11	45	15	19	7	16
26	14	16	28	7	15	3	27	56	30	44	42	15	36	7	24
27	14	49	24	7	31	3	34	57	31	17	38	15	53	7	32
28	15	22	21	7	48	3	42	58	31	50	34	16	10	7	40
29	15	55	17	8	05	3	50	59	32	23	31	16	26	7	48
30	16	28	14	8	21	3	58	60	32	56	27	16	43	7	56

In the Leap-year after *February* add a Day to the given time, and its Motions to the Motions Collected.

A TABLE *of Physical Parts, to be added to or subtracted from the Moons Mean Motion, according to the Suns Mean Anomaly.*

Suns Mean Anomaly.	Add. 0		1		2		3		4		5		
	′	″	′	″	′	″	′	″	′	″	′	″	
0	0	00	5	36	9	51	11	30	10	04	5	51	30
1	0	12	5	47	9	57	11	30	9	58	5	40	29
2	0	23	5	58	10	03	11	30	9	51	5	30	28
3	0	35	6	09	10	09	11	30	9	45	5	19	27
4	0	47	6	19	10	14	11	29	9	39	5	08	26
5	0	59	6	29	10	19	11	28	9	32	4	57	25
6	1	10	6	39	10	25	11	27	9	25	4	46	24
7	1	22	6	48	10	30	11	26	9	18	4	35	23
8	1	33	6	58	10	34	11	25	9	11	4	23	22
9	1	45	7	07	10	39	11	24	9	03	4	12	21
10	1	56	7	16	10	43	11	22	8	55	4	00	20
11	2	08	7	25	10	48	11	20	8	48	3	49	19
12	2	19	7	34	10	52	11	18	8	40	3	37	18
13	2	31	7	43	10	56	11	15	8	32	3	25	17
14	2	42	7	52	10	59	11	13	8	23	3	14	16
15	2	54	8	01	11	02	11	10	8	15	3	02	15
16	3	05	8	09	11	06	11	07	8	06	2	50	14
17	3	16	8	17	11	09	11	04	7	58	2	38	13
18	3	27	8	25	11	12	11	00	7	49	2	26	12
19	3	39	8	33	11	14	10	57	7	40	2	14	11
20	3	50	8	41	11	17	10	53	7	30	2	02	10
21	4	01	8	49	11	19	10	50	7	21	1	50	9
22	4	12	8	57	11	21	10	45	7	12	1	38	8
23	4	22	9	04	11	23	10	40	7	02	1	26	7
24	4	33	9	11	11	24	10	35	6	52	1	13	6
25	4	44	9	18	11	26	10	31	6	42	1	01	5
26	4	55	9	25	11	27	10	26	6	32	0	49	4
27	5	05	9	32	11	28	10	20	6	22	0	37	3
28	5	16	9	38	11	29	10	15	6	12	0	24	2
29	5	26	9	45	11	29	10	09	6	02	0	12	1
30	5	36	9	51	11	30	10	04	5	51	0	00	0
	11		10		9		8		7		6		

Subtract.

The Equations of the Moons Apoge and the Excentricities of her Orbit, in such Parts as the Radius is, 1000000.

Add the Equations of the Apoge.

Annual Argu.	Sign 0 6 °	'	"	Excen. Parts.	Sign 1 7 °	'	"	Excen. Parts.	Sign 2 8 °	'	"	Excen. Parts.	Annual Argu.
0	0	00	00	66854	09	07	14	61045	11	08	55	49429	30
1	0	20	21	66847	09	20	52	60691	10	59	45	49082	29
2	0	40	42	66826	09	34	01	60330	10	49	35	48741	28
3	1	01	01	66791	09	46	40	59962	10	38	22	48408	27
4	1	21	17	66741	09	58	49	59589	10	26	07	48085	26
5	1	41	30	66678	10	10	24	59210	10	12	50	47769	25
6	2	01	40	66600	10	21	29	58827	09	58	31	47463	24
7	2	21	44	66509	10	31	58	58439	09	43	10	47167	23
8	2	41	42	66404	10	41	50	58047	09	26	48	46880	22
9	3	01	34	66286	10	51	08	57652	09	09	24	46604	21
10	3	21	18	66154	10	59	48	57254	08	51	00	46337	20
11	3	40	54	66008	11	07	47	56854	08	31	36	46082	19
12	4	00	21	65850	11	15	07	56451	08	11	14	45838	18
13	4	19	38	65679	11	21	45	56047	07	49	55	45606	17
14	4	38	44	65495	11	27	40	55642	07	27	40	45385	16
15	4	57	38	65298	11	32	51	55237	07	04	31	45176	15
16	5	16	20	65089	11	37	17	54832	06	40	30	44979	14
17	5	34	49	64868	11	40	55	54427	06	15	40	44795	13
18	5	53	02	64636	11	43	47	54023	05	50	02	44624	12
19	6	11	01	64392	11	45	49	53620	05	23	39	44466	11
20	6	28	43	64137	11	47	01	53220	04	56	34	44320	10
21	6	46	03	63870	11	47	22	52822	04	28	51	44188	9
22	7	03	15	63594	11	46	50	52427	04	00	32	44070	8
23	7	20	03	63307	11	45	24	52035	03	31	40	43965	7
24	7	36	30	63011	11	43	04	51647	03	02	20	43874	6
25	7	52	36	62705	11	39	47	51264	02	32	26	43796	5
26	8	08	20	62389	11	35	34	50885	02	02	30	43733	4
27	8	23	41	62066	11	30	23	50512	01	32	08	43683	3
28	8	38	38	61733	11	24	14	50144	01	01	30	43648	2
29	8	53	08	61392	11	17	05	49783	00	30	45	43627	1
30	9	07	14	61045	11	08	55	49429	00	00	00	43619	0
	Sign 5 11				Sign 4 10				Sign 3 9				

Subtract, &c.

A TABLE of the Equations of the Moons Center.

Subtract.

Mean Anomaly	Sign 0. Least Exc 43619	Middle. 55237	Greatest. 66854	Sign 1. Least Exc 43619	Middle. 55237	Greatest. 65854	Mean Anomaly
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	0 00 00	0 00 00	0 00 00	2 23 08	2 59 04	3 34 08	30
1	0 04 58	0 06 12	0 07 24	2 27 32	3 04 33	3 40 43	29
2	0 09 56	0 12 24	0 14 48	2 31 50	3 10 00	3 47 15	28
3	0 14 53	0 18 35	0 22 12	2 36 07	3 15 23	3 53 43	27
4	0 19 50	0 24 47	0 29 36	2 40 22	3 20 44	4 00 08	26
5	0 24 48	0 30 58	0 36 58	2 44 35	3 26 01	4 06 30	25
6	0 29 44	0 37 09	0 44 20	2 48 48	3 31 16	4 12 47	24
7	0 34 39	0 43 19	0 51 42	2 52 53	3 36 27	4 19 01	23
8	0 39 34	0 49 27	0 59 04	2 56 54	3 41 35	4 25 12	22
9	0 44 30	0 55 36	1 06 25	3 00 58	3 46 39	4 31 18	21
10	0 49 25	1 01 43	1 13 45	3 04 55	3 51 39	4 37 20	20
11	0 54 19	1 07 51	1 21 02	3 08 53	3 56 36	4 48 18	19
12	0 59 13	1 13 57	1 28 18	3 12 46	4 01 30	4 49 12	18
13	1 04 04	1 20 02	1 35 34	3 16 35	4 06 20	4 55 01	17
14	1 08 56	1 26 05	1 42 49	3 20 22	4 11 06	5 00 46	16
15	1 13 45	1 32 07	1 50 02	3 24 05	4 15 47	5 06 26	15
16	1 18 33	1 38 08	1 57 13	3 27 44	4 20 24	5 12 01	14
17	1 23 20	1 44 08	2 04 23	3 31 20	4 24 58	5 17 32	13
18	1 28 06	1 50 06	2 11 31	3 34 93	4 29 28	5 22 59	12
19	1 32 50	1 56 02	2 18 37	3 38 22	4 33 53	5 28 20	11
20	1 37 32	2 01 56	2 25 41	3 41 47	4 38 14	5 33 36	10
21	1 42 13	2 07 49	2 32 43	3 45 09	4 42 31	5 38 47	9
22	1 46 53	2 13 39	2 39 43	3 48 28	4 46 43	5 43 53	8
23	1 51 33	2 19 27	2 46 40	3 51 43	4 50 50	5 48 53	7
24	1 56 09	2 25 14	2 53 35	3 54 55	4 54 53	5 53 48	6
25	2 00 45	2 30 58	3 00 28	3 58 03	4 58 55	5 58 38	5
26	2 05 18	2 36 41	3 07 18	4 01 06	5 02 43	6 03 21	4
27	2 09 49	2 42 21	3 14 05	4 04 05	5 06 32	6 07 59	3
28	2 14 18	2 47 58	3 20 49	4 07 00	5 10 15	6 12 31	2
29	2 18 44	2 53 32	3 27 30	4 09 51	5 13 54	6 16 58	1
30	2 23 08	2 59 04	3 34 08	4 12 40	5 17 27	6 21 18	0
	Sign 11.			Sign 10.			

Add.

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A TABLE of the Equations of the Moons Center.

Subtract.

Mean Anomaly	Sign 2. Least Exc 43619	Middle. 55[illegible]	Greatest. 66854	Sign 3. Least Exc 43619	Middle. 55[illegible]	Greatest. 66854	Mean Anomaly
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	4 12 40	5 17 27	6 21 18	4 59 30	6 18 59	7 38 17	30
1	4 15 18	5 20 54	6 25 32	4 59 48	6 19 23	7 38 52	29
2	4 17 56	5 24 17	6 29 39	4 59 56	6 19 40	7 39 20	28
3	4 20 28	5 27 35	6 33 40	4 59 59	6 19 50	7 39 40	27
4	4 23 00	5 30 47	6 37 36	4 59 58	6 19 54	7 39 51	26
5	4 25 24	5 33 53	6 41 25	4 59 49	6 19 51	7 39 53	25
6	4 27 44	5 36 54	6 45 08	4 59 36	6 19 40	7 39 47	24
7	4 30 00	5 39 49	6 48 44	4 59 20	6 19 23	7 39 33	23
8	4 32 12	5 42 39	6 52 14	4 58 53	6 18 57	7 39 09	22
9	4 34 19	5 45 24	6 55 36	4 58 24	6 18 25	7 38 37	21
10	4 36 21	5 48 02	6 58 52	4 57 48	6 17 46	7 37 58	20
11	4 38 18	5 50 35	7 02 01	4 57 06	6 17 00	7 37 09	19
12	4 40 12	5 53 02	7 05 03	4 56 19	6 16 08	7 36 12	18
13	4 41 58	5 55 22	7 07 57	4 55 27	6 15 08	7 35 06	17
14	4 43 41	5 57 36	7 10 45	4 54 30	6 14 00	7 33 52	16
15	4 45 19	5 59 44	7 13 25	4 53 27	6 12 46	7 32 29	15
16	4 46 53	6 01 46	7 15 58	4 52 19	6 11 25	7 30 57	14
17	4 48 22	6 03 42	7 18 24	4 51 03	6 09 56	7 29 17	13
18	4 49 44	6 05 31	7 20 42	4 49 45	6 08 20	7 27 28	12
19	4 51 02	6 07 15	7 22 53	4 48 21	6 06 37	7 25 30	11
20	4 52 15	6 08 52	7 24 56	4 46 51	6 04 48	7 23 23	10
21	4 53 22	6 10 23	7 26 52	4 45 16	6 02 51	7 21 08	9
22	4 54 23	6 11 46	7 28 39	4 43 34	6 00 48	7 18 44	8
23	4 55 20	6 13 03	7 30 20	4 41 44	5 58 37	7 16 12	7
24	4 56 12	6 14 14	7 31 52	4 39 56	5 56 19	7 13 30	6
25	4 56 59	6 15 19	7 33 16	4 37 58	5 53 54	7 10 40	5
26	4 57 38	6 16 17	7 34 32	4 35 56	5 51 23	7 07 42	4
27	4 58 14	6 17 08	7 35 40	4 33 47	5 48 43	7 04 35	3
28	4 58 45	6 17 52	7 36 41	4 31 33	5 45 57	7 01 19	2
29	4 59 10	6 18 29	7 37 34	4 29 13	5 43 04	6 57 55	1
30	4 59 30	6 18 59	7 38 17	4 26 49	5 40 05	6 54 28	0
	Sign 9.			Sign 8.			

Add.

A TABLE of the Equations of the Moons Center.

Subtract.

Mean Anomaly	Signs 4. Least Exc 43619	Middle. 55237	Greatest. 66854	Signs 5. Least Exc 43619	Middle. 55237	Greatest. 66854	Mean Anomaly
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	4 26 49	5 40 05	6 54 23	2 37 10	3 21 48	4 07 29	30
1	4 24 19	5 37 00	6 50 42	2 32 27	3 15 48	4 00 10	29
2	4 21 43	5 33 46	6 46 52	2 27 42	3 09 44	3 52 45	28
3	4 19 01	5 30 25	6 42 54	2 22 54	3 03 36	3 45 14	27
4	4 16 14	5 26 57	6 38 48	2 18 03	2 57 24	3 37 39	26
5	4 13 22	5 23 24	6 34 34	2 13 09	2 51 06	3 29 59	25
6	4 10 25	5 19 43	6 30 11	2 08 13	2 44 45	3 22 14	24
7	4 07 24	5 15 58	6 25 40	2 03 14	2 38 22	3 14 24	23
8	4 04 18	5 12 06	6 21 01	1 58 12	2 31 55	3 06 30	22
9	4 01 08	5 08 07	6 16 14	1 53 07	2 25 24	2 58 31	21
10	3 57 53	5 04 00	6 11 20	1 48 01	2 18 50	2 50 29	20
11	3 54 32	4 59 48	6 06 16	1 42 52	2 12 13	2 42 23	19
12	3 51 07	4 55 30	6 01 06	1 37 41	2 05 32	2 34 12	18
13	3 47 38	4 51 06	5 55 49	1 32 27	1 58 49	2 25 58	17
14	3 44 04	4 46 36	5 50 21	1 27 11	1 52 05	2 17 41	16
15	3 40 27	4 42 00	5 44 48	1 21 54	1 45 17	2 09 21	15
16	3 36 43	4 37 17	5 39 06	1 16 35	1 38 26	2 00 58	14
17	3 32 55	4 32 27	5 33 17	1 11 14	1 31 33	1 52 31	13
18	3 29 02	4 27 32	5 27 22	1 05 55	1 24 38	1 44 01	12
19	3 25 05	4 22 33	5 21 19	1 00 27	1 17 42	1 35 29	11
20	3 21 04	4 17 28	5 15 09	0 55 02	1 10 44	1 26 55	10
21	3 16 59	4 12 17	5 08 52	0 49 34	1 03 43	1 18 19	9
22	3 12 48	4 07 01	5 02 28	0 44 07	0 56 42	1 09 42	8
23	3 08 34	4 01 40	4 55 58	0 38 37	0 49 30	1 01 03	7
24	3 04 16	3 56 13	4 49 21	0 33 08	0 42 36	0 52 22	6
25	2 59 53	3 50 40	4 42 38	0 27 38	0 35 30	0 43 40	5
26	2 55 27	3 45 03	4 35 48	0 22 08	0 28 25	0 34 57	4
27	2 50 58	3 39 21	4 28 52	0 16 37	0 21 19	0 26 13	3
28	2 46 26	3 33 34	4 21 49	0 11 04	0 14 13	0 17 29	2
29	2 41 50	3 27 43	4 14 41	0 05 32	0 07 07	0 08 45	1
30	2 37 10	3 21 48	4 07 29	0 00 00	0 00 00	0 00 00	0
	Signs 7			Signs 6			

Add.

A TABLE of the Variation.

	Add.						
	Sign 0 6		Sign 1 7		Sign 2 8		
	°	′	°	′	°	′	
0	00	00	32	54	32	54	30
1	01	20	33	33	32	13	29
2	02	39	34	09	31	39	28
3	03	59	34	42	30	45	27
4	05	18	35	13	29	57	26
5	06	36	35	42	29	07	25
6	07	54	36	09	28	14	24
7	09	11	36	32	27	20	23
8	10	28	36	52	26	24	22
9	11	44	37	10	25	26	21
10	13	00	37	25	24	25	20
11	14	14	37	38	23	23	19
12	15	27	37	48	22	20	18
13	16	40	37	55	21	15	17
14	17	51	37	59	20	08	16
15	19	00	38	00	19	00	15
16	20	08	37	59	17	51	14
17	21	15	37	55	16	40	13
18	22	20	37	48	15	27	12
19	23	23	37	38	14	14	11
20	24	25	37	25	13	00	10
21	25	26	37	10	11	44	9
22	26	24	36	52	10	28	8
23	27	20	36	32	09	11	7
24	28	14	36	09	07	54	6
25	29	07	35	42	06	36	5
26	29	57	35	13	05	18	4
27	30	45	34	42	03	59	3
28	31	30	34	09	02	39	2
29	32	13	33	33	01	20	1
30	32	54	32	54	00	00	0
	Sign 11 5		Sign 10 4		Sign 9 3		
	Subtract.						

A Table of the Equati. of the Node, and Inclinations of the Limit above 5 Deg.

Equation of the ☊ Add.

☉ a ☊ diff.	Signs 0 / 6: Equati. ☊ °	'	"	Inc. Lim '	"	Signs 1 / 7: Equati. ☊ °	'	"	Inc. Lim '	"	Signs 2 / 8: Equati. ☊ °	'	"	Inc. Lim '	"	☉ a ☊ diff.
0	0	00	00	18	00	1	25	12	13	30	1	26	50	04	30	30
1	0	03	28	18	00	1	27	00	13	14	1	25	01	04	14	29
2	0	06	56	17	59	1	28	37	12	57	1	23	06	03	59	28
3	0	10	23	17	59	1	30	04	12	40	1	21	06	03	43	27
4	0	13	49	17	55	1	31	22	12	23	1	19	03	03	28	26
5	0	17	11	17	52	1	32	30	12	05	1	16	56	03	13	25
6	0	20	31	17	48	1	33	34	11	47	1	14	44	02	59	24
7	0	23	48	17	43	1	34	34	11	29	1	12	26	02	45	23
8	0	27	02	17	38	1	35	31	11	11	1	10	02	02	32	22
9	0	30	13	17	34	1	36	25	10	53	1	07	31	02	19	21
10	0	33	22	17	28	1	37	15	10	34	1	04	53	02	06	20
11	0	36	29	17	21	1	37	59	10	14	1	02	09	01	54	19
12	0	39	34	17	13	1	38	37	09	55	0	59	19	01	43	18
13	0	42	37	17	05	1	39	09	09	37	0	56	23	01	32	17
14	0	45	38	16	57	1	39	33	09	18	0	53	21	01	22	16
15	0	48	37	16	48	1	39	46	09	00	0	50	15	01	12	15
16	0	51	33	16	38	1	39	34	08	42	0	47	06	01	03	14
17	0	54	27	16	28	1	39	11	08	23	0	43	56	00	55	13
18	0	57	17	16	17	1	38	41	08	05	0	40	44	00	47	12
19	1	00	06	16	06	1	38	05	07	46	0	37	29	00	39	11
20	1	02	51	15	54	1	37	23	07	26	0	34	12	00	32	10
21	1	05	31	15	41	1	36	34	07	07	0	30	53	00	26	9
22	1	08	04	15	28	1	35	46	06	49	0	27	32	00	22	8
23	1	10	29	15	15	1	34	56	06	31	0	24	09	00	17	7
24	1	12	48	15	01	1	34	03	06	13	0	20	44	00	12	6
25	1	15	01	14	47	1	33	06	05	55	0	17	18	00	08	5
26	1	17	08	14	32	1	32	05	05	37	0	13	51	00	05	4
27	1	19	12	14	17	1	31	00	05	20	0	10	24	00	03	3
28	1	21	14	14	01	1	29	47	05	03	0	06	57	00	01	2
29	1	23	14	13	46	1	28	24	04	46	0	03	29	00	00	1
30	1	25	12	13	30	1	26	50	04	30	0	00	00	00	00	0
	Signs 5 / 11					Signs 4 / 10					Signs 3 / 9					

Equation of the Node Subtract.

A TABLE of the Moons simple Latitude, to the least Inclination of her Orbit 5 Degrees, with the parts to be added when 'tis 5°18'.

Arg. of Lat.	Sign 0 Nor. 6 Sou. D^t Latitude.			Increm. or parts to be added.		Sign 1 Nor. 7 Sou. D^t Latitude.			Increm. or parts to be added.		Sign 2 Nor. 8 Sou. D^t Latitude.			Increm. or parts to be added.		Arg. of Lat.
	°	′	″	′	″	°	′	″	′	″	°	′	″	′	″	
0	0	00	00	0	00	2	29	51	9	00	4	19	44	15	36	30
1	0	05	14	0	19	2	34	22	9	16	4	22	18	15	45	29
2	0	10	28	0	37	2	38	50	9	32	4	24	49	15	54	28
3	0	15	42	0	56	2	43	15	9	48	4	27	14	16	02	27
4	0	20	55	1	15	2	47	37	10	03	4	29	34	16	11	26
5	0	26	08	1	34	2	51	56	10	19	4	31	50	16	19	25
6	0	31	20	1	53	2	56	11	10	34	4	34	00	16	27	24
7	0	36	32	2	11	3	00	24	10	49	4	36	06	16	34	23
8	0	41	43	2	30	3	04	33	11	04	4	38	06	16	42	22
9	0	46	53	2	49	3	08	39	11	19	4	40	02	16	49	21
10	0	52	02	3	08	3	12	42	11	34	4	41	52	16	55	20
11	0	57	10	3	26	3	16	41	11	48	4	43	37	17	01	19
12	1	02	18	3	45	3	20	36	12	02	4	45	17	17	07	18
13	1	07	24	4	03	3	24	28	12	16	4	46	52	17	12	17
14	1	12	29	4	21	3	28	16	12	30	4	48	21	17	18	16
15	1	17	33	4	39	3	32	00	12	44	4	49	45	17	23	15
16	1	22	36	4	57	3	35	40	12	56	4	51	04	17	28	14
17	1	27	37	5	15	3	39	17	13	09	4	52	18	17	33	13
18	1	32	36	5	33	3	42	49	13	22	4	53	26	17	37	12
19	1	37	34	5	51	3	46	17	13	35	4	54	28	17	40	11
20	1	42	29	6	09	3	49	42	13	47	4	55	26	17	44	10
21	1	47	23	6	27	3	53	02	13	59	4	56	18	17	47	9
22	1	52	16	6	45	3	56	17	14	11	4	57	04	17	50	8
23	1	57	06	7	02	3	59	29	14	23	4	57	45	17	52	7
24	2	01	54	7	19	4	02	36	14	34	4	58	21	17	54	6
25	2	06	39	7	36	4	05	39	14	45	4	58	51	17	56	5
26	2	11	23	7	53	4	08	37	14	56	4	59	16	17	58	4
27	2	16	04	8	09	4	11	30	15	06	4	59	35	17	59	3
28	2	20	42	8	26	4	14	19	15	17	4	59	49	17	59	2
29	2	25	18	8	42	4	17	04	15	26	4	59	57	18	00	1
30	2	29	51	9	00	4	19	44	15	36	5	00	00	18	00	0
	Sign 5 Nor. 11 Sou.					Sign 4 Nor. 10 Sou.					Sign 3 Nor. 9 Sou.					

A TABLE of the Reduction when the Inclination of the Orbit is 5 Degrees, with the excess when it is 5°18'.

Arg. of Lati.	Sign 0/6 Sub. Reduction	Excess.	Sign 1/7 Sub. Reduction	Excess.	Sign 2/8 Sub. Reduction	Excess.	Arg. of Lati.
	' "	"	' "	"	° ' "	"	
0	0 00	02	5 40	42	5 41	42	30
1	0 14	02	5 47	43	5 34	41	29
2	0 27	04	5 53	44	5 26	40	28
3	0 41	06	5 59	45	5 18	39	27
4	0 55	08	6 04	46	5 10	38	26
5	1 08	09	6 09	46	5 02	37	25
6	1 22	11	6 14	46	4 53	36	24
7	1 35	12	6 18	47	4 43	35	23
8	1 48	13	6 21	47	4 34	34	22
9	2 01	15	6 24	47	4 23	33	21
10	2 14	17	6 27	48	4 13	31	20
11	2 27	19	6 29	48	4 02	30	19
12	2 40	20	6 31	48	3 51	29	18
13	2 52	22	6 32	48	3 40	28	17
14	3 04	23	6 33	49	3 29	26	16
15	3 16	24	6 33	49	3 17	24	15
16	3 28	26	6 33	49	3 05	23	14
17	3 40	28	6 32	49	2 53	22	13
18	3 51	29	6 31	49	2 40	20	12
19	4 02	30	6 29	48	2 28	19	11
20	4 12	31	6 27	48	2 15	17	10
21	4 23	33	6 25	47	2 02	15	9
22	4 33	34	6 22	47	1 49	13	8
23	4 44	35	6 18	47	1 35	12	7
24	4 52	36	6 14	46	1 22	11	6
25	4 01	37	6 10	46	1 08	9	5
26	5 09	38	6 05	46	0 55	8	4
27	5 18	39	6 00	45	0 41	6	3
28	5 26	40	5 54	44	0 27	4	2
29	5 33	41	5 47	43	0 14	2	1
30	5 40	42	5 41	42	0 00	0	0
	Sign 5 11		Sign 4 10		Sign 9 3		

Add.

A Table of the Moons true horary Motion in Eclipses, her horizontal Semidiameters, and Parallaxes, under her least and greatest Excentricities, with the Suns true hourly Motions and Semidiameters.

Mean Anomaly.	Earths true hourly Moti.	Suns Semidiameter.	Moons true hourly Moti. Excentricity. 4362	6685	Moons horizontal Paral. Excentricity. 4362	6685	Moons horizontal Semidi. Excentricity. 4362	6685	Mean Anomaly.
° ′	′ ″	′ ″	′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′
0 00	2 23	15 50	30 51	29 30	55 35	54 23	15 04	14 45	12 00
06	2 23	15 50	30 52	29 31	55 38	54 23	15 05	14 45	24
12	2 23	15 50	30 55	29 33	55 38	54 26	15 05	14 46	18
18	2 23	15 50	30 59	29 39	55 43	54 31	15 06	14 47	12
24	2 23	15 51	31 03	29 47	55 48	54 38	15 08	14 49	06
1 00	2 23	15 52	31 10	29 57	55 54	54 47	15 10	14 52	11 00
06	2 24	15 53	31 19	30 09	56 01	54 58	15 12	14 55	24
12	2 24	15 54	31 29	30 22	56 09	55 11	15 14	14 58	18
18	2 24	15 55	31 40	30 37	56 19	55 25	15 16	15 02	12
24	2 25	15 56	31 52	30 55	56 30	55 41	15 19	15 06	06
2 00	2 25	15 58	32 06	31 15	56 42	55 58	15 23	15 11	10 00
06	2 26	15 59	32 21	31 36	56 56	56 17	15 27	15 16	24
12	2 26	16 01	32 36	31 59	57 10	56 37	15 30	15 21	18
18	2 27	16 02	32 54	32 24	57 25	56 59	15 34	15 27	12
24	2 27	16 04	33 11	32 50	57 39	57 22	15 38	15 34	06
3 00	2 28	16 06	33 29	33 18	57 54	57 45	15 42	15 40	9 00
06	2 28	6 08	33 47	33 47	58 10	58 10	15 47	15 46	24
12	2 29	16 09	34 07	34 15	58 27	58 35	15 51	15 53	18
18	2 29	16 11	34 26	34 43	58 43	59 01	15 55	16 01	12
24	2 30	16 13	34 45	35 12	58 58	59 25	16 00	16 07	06
4 00	2 30	16 14	35 03	35 42	59 13	59 48	16 04	16 14	8 00
06	2 31	16 15	35 20	36 10	59 28	60 12	16 08	16 20	24
12	2 31	16 17	35 36	36 36	59 43	60 35	16 12	16 26	18
18	2 32	16 19	35 51	37 01	59 56	60 56	16 16	16 32	12
24	2 32	16 20	36 05	37 24	60 07	61 14	16 19	16 37	06
5 00	2 32	16 21	36 17	37 45	60 16	61 30	16 21	16 41	7 00
06	2 33	16 21	36 27	38 02	60 24	61 44	16 23	16 45	24
12	2 33	16 22	36 34	38 15	60 30	61 55	16 25	16 48	18
18	2 33	16 22	36 39	38 25	60 35	62 03	16 26	16 50	12
24	2 33	16 23	36 43	38 31	60 38	62 08	16 27	16 51	06
6 00	2 33	16 23	36 44	38 32	60 39	62 10	16 27	16 52	6 00

A TABLE of the Angle which the true Motion of the Moon from the Sun, makes with the Ecliptick in the ☌ and ☍.

Arg. of Latitu	The true hourly Motion of the Moon from the Sun.										Arg. of Latitu.
Sig. 0	27′	28′	29′	30	31′	32′	33′	34′	35′	36′	Sig. 5.
Sig. 6	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	Sig. 11
gr. 0	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	gr. 30
1	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	29
2	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	28
3	5 46	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	27
4	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	26
5	5 45	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	25
6	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 35	24
7	5 44	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 35	23
8	5 43	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 35	5 34	22
9	5 42	5 41	5 40	5 39	5 38	5 37	5 36	5 35	5 34	5 33	21
10	5 41	5 40	5 39	5 38	5 37	5 36	5 35	5 34	5 33	5 32	20
11	5 40	5 39	5 38	5 37	5 36	5 35	5 34	5 33	5 32	5 31	19
12	5 39	5 38	5 37	5 36	5 35	5 34	5 33	5 32	5 31	5 30	18

TABLE XIX.

A TABLE of the time of Reduction, or betwixt the true ☌ or ☍ of the Luminaries, and the neareſt Approach of their Centers.

Arg. of Latitu.	Subtract from the time of the true ☌ or ☍ in the Orbit. The true hourly Motion of the Moon from the Sun.										Arg. of Latitu.
Sig. 0	27′	28′	29′	30′	31′	32′	33′	34′	35′	36′	Sig. 5
Sig. 6	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	Sig. 11
gr. 0	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	gr. 30
1	0 35	0 34	0 33	0 31	0 30	0 29	0 28	0 27	0 26	0 26	29
2	1 10	1 07	1 05	1 03	1 00	0 58	0 56	0 55	0 53	0 51	28
3	1 45	1 41	1 37	1 34	1 30	1 27	1 25	1 22	1 19	1 17	27
4	2 20	2 15	2 10	2 05	2 00	1 56	1 53	1 49	1 45	1 42	26
5	2 55	2 48	2 42	2 36	2 30	2 25	2 21	2 16	2 12	2 08	25
6	3 29	3 21	3 14	3 07	3 00	2 54	2 48	2 43	3 38	2 33	24
7	4 04	3 54	3 46	3 38	3 30	3 23	3 16	3 10	3 04	2 58	23
8	4 38	4 27	4 17	4 08	3 59	3 51	3 43	3 36	3 09	3 23	22
9	5 11	4 59	4 48	4 38	4 28	4 19	4 10	4 02	3 54	3 47	21
10	5 44	5 31	5 19	5 07	4 56	4 46	4 37	4 28	4 19	4 21	20
11	6 17	6 03	5 49	5 37	5 25	5 14	5 03	4 53	4 44	4 35	19
12	6 50	6 34	6 19	6 06	5 52	5 41	5 29	5 19	5 09	4 59	18

Add to the time of the true ☌ or ☍ of the Sun and Moon in her Orbit.

A TABLE of the Mean Motions of the Moon from the Sun.

Current Y. of Christ.	The Mean Motion of the ☽ from the ☉				Compleat years.	The Mean Motion of the ☽ from the ☉.				Days.	The Mean Motion of the ☽ from the ☉.				H.	M. Motion			M. Motion		
	°	′	″	‴		°	′	″	‴		°	′	″	‴		°	′	″	′	″	‴
1	06	23	31	29	1	04	09	37	23	1	00	12	11	27	1	00	30	29	31	15	44	47
1501	04	10	26	36	2	08	19	14	45	2	01	24	22	53	2	01	00	57	32	16	15	16
1581	10	04	05	33	3	00	28	52	07	3	01	06	34	20	3	01	31	26	33	16	45	44
1601	02	17	30	17	4	05	20	40	57	4	01	18	45	47	4	02	01	54	34	17	16	13
1621	07	00	55	01	5	10	00	18	20	5	02	00	57	13	5	02	32	23	35	17	46	42
1641	11	14	19	45	6	02	09	55	42	6	02	13	08	40	6	03	02	54	36	18	17	10
1661	03	27	44	29	7	06	19	33	04	7	02	25	20	07	7	03	33	20	37	18	47	39
1681	08	11	09	13	8	11	11	21	54	8	03	07	31	33	8	04	03	49	38	19	18	07
1701	00	24	33	57	9	03	20	59	17	9	03	19	43	00	9	04	34	18	39	19	48	36
1721	05	07	58	41	10	08	00	36	39	10	04	01	54	27	10	05	04	46	40	20	19	05
1741	09	21	23	25	11	00	10	14	01	11	04	14	05	53	11	05	35	15	41	20	49	33
1761	02	04	48	09	12	05	02	02	50	12	04	26	17	20	12	06	05	43	42	21	20	02
1781	06	18	12	54	13	09	11	40	13	13	05	08	28	47	13	06	36	12	43	21	50	31
1801	11	01	37	38	14	01	21	17	35	14	05	20	40	13	14	07	06	41	44	22	20	59
1901	09	08	41	18	15	06	00	54	57	15	06	02	51	40	15	07	37	09	45	22	51	28
2001	07	15	44	59	16	10	22	43	47	16	06	15	03	07	16	08	07	38	46	23	21	56
					17	03	02	21	10	17	06	27	14	33	17	08	38	06	47	23	52	25
					18	07	11	58	32	18	07	09	26	00	18	09	08	35	48	24	22	54
					19	11	21	35	54	19	07	21	37	27	19	09	39	04	49	24	53	22
					20	04	13	24	44	20	08	03	48	53	20	10	09	32	50	25	23	51
										21	08	16	00	20	21	10	40	01	51	25	54	19
										22	08	28	11	47	22	11	10	30	52	26	24	48
										23	09	10	23	13	23	11	40	58	53	26	55	17
										24	09	22	34	40	24	12	11	27	54	27	25	45
										25	10	04	46	07	25	12	41	55	55	27	56	13
										26	10	16	57	33	26	13	12	24	56	28	26	43
										27	10	29	09	00	27	13	42	53	57	28	57	11
										28	11	11	20	27	28	14	13	21	58	29	27	40
										29	11	23	31	53	29	14	43	50	59	29	58	08
										30	00	05	43	20	30	15	14	19	60	30	28	37
										31	00	17	54	47								
										32	01	00	06	13								

Comple. Julian Y.	Motion of the ☽ from the ☉.			
	°	′	″	‴
20	04	13	24	44
40	08	26	49	28
60	01	10	14	12
80	05	23	38	56
100	10	07	03	40
200	08	14	07	21
300	06	21	11	01
400	04	28	14	42
500	03	05	18	22
600	01	12	22	03
700	11	19	25	43
800	09	26	29	24
900	08	03	33	04
1000	06	10	36	45
2000	00	21	13	30
3000	07	01	50	15
4000	01	12	27	00
5000	07	23	03	45

Months.	Motion of the ☽ from the ☉.			
	°	′	″	‴
Jan.	00	00	00	00
Feb.	00	17	54	47
Mar.	11	29	15	14
Apr.	00	17	10	02
May.	00	22	53	22
June.	01	10	48	10
July.	01	16	31	32
Aug.	02	04	26	18
Sep.	02	21	21	06
Oct.	02	28	04	27
Nov.	03	15	59	14
Dec.	03	21	42	34

In the Leap-year add a Day to the Time, and a Days Motion to the Motion Collected.